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OF THE

New England Water Works ASSOCIATION.

1890-91.

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NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. V. September, 1890. No. 1.

This Association, as a Body, is not responsible for statements or opinions of any of its members.

PROCEEDINGS OF THE NINTH ANNUAL CONVENTION.

PORTLAND, ME., June 11, 12, and 13, 1890.

The ninth annual convention of the Association was holden, through the courtesy of the City Council of Portland, in the City Hall building. Adjoining the hall in which the convention was holden were rooms connecting with the hall, which, also through the courtesy of the City Council, were used for the usual exhibition of water-works supplies.

AFTERNOON SESSION.

WEDNESDAY, June 11, 1890.

The PRESIDENT. — The hour has arrived and passed for opening the first session of our convention. I will announce that the programme for the afternoon will be varied somewhat, and the Association will be formally welcomed by the Mayor of the city this evening instead of at the present time. We will now proceed with our regular business, the first item of which is the reading of the minutes of the last meeting.

It was voted that the reading of the records of last year be waived.

The PRESIDENT. — We will now take up the consideration of applicants for membership.

The SECRETARY. — I have the following list of applicants for membership, who have been passed by the Executive Committee, and are recommended to the Association for election: —

RESIDENT ACTIVE MEMBERS.

A. F. Crockett, President Camden & Rockland Water Co., Rockland, Me.

James Burnie, Superintendent Water Company, Biddeford, Me.

Francis W. Dean, Hydraulic Engineer, Boston, Mass.

Eben R. Dyer, Superintendent Construction Water Company, Portland, Me.

Charles R. Dyer, Superintendent Meter Department, Water Company, Portland, Me.

W. J. Goldthwaite, Water Commissioner, Marblehead, Mass.

Frederick W. Gow, Assistant Superintendent Water Works, Medford, Mass.

Arthur W. Hunking, Hydraulic Engineer, Lowell, Mass.
William Jackson, City Engineer, Boston, Mass.
James T. Murphy, Water Commissioner, Marlboro', Mass.
William McNally, Water Registrar, Marlboro', Mass.

NON-RESIDENT ACTIVE MEMBERS.

William Hamilton, Superintendent Water Works, Toronto, Ont.
Charles W. Pratt, Superintendent Water Works, Utica, N.Y.
J. Nelson Tubbs, Chief Engineer Water Works, Rochester, N.Y.
E. M. Treman, Superintendent Water Works, Ithaca, N.Y.

ASSOCIATE MEMBERS.

James C. Bayles, Hydraulic Engineer, East Orange, N.J.
King & Goddard, Pipe Fittings, etc., Boston, Mass.
Perrin, Seamans, & Co., Water-Works Supplies, Boston, Mass.
Standard Thermometer Co., Electric Instruments, Peabody, Mass.
Rensselaer Manufacturing Co., Valves, etc., Troy, N.Y.
Taunton Locomotive Manufacturing Co., Machine Works, Taunton, Mass.
J. N. Winslow, President Stoneware Co., Portland, Me.
E. B. Winslow, General Manager Stoneware Co., Portland, Me.

On motion of Mr. Fuller, the Secretary was empowered to cast the vote of the Association for the list as read, which the Secretary did, and the members were declared elected.

THE PRESIDENT'S ADDRESS.

The President then addressed the Association as follows: —

Fellow-Members of the New England Water Works Association: — We have assembled here to-day, in this beautiful city, to hold our ninth annual convention. The few minutes of your time which I shall occupy, I propose to devote to a brief statement of the work of the Association.

From a membership of 43 at the second annual convention at Worcester in 1883, our numbers have increased steadily, year by year, until we now have a total membership of 335, divided into three classes: 257 active, 5 honorary, and 73 associate members. About 200 of the active members are residents of New England, representing the water departments of 100 cities and towns.

It seems to me that the growth of the Association, and the good work which it has accomplished during the past eight years, must have exceeded the most sanguine expectations of its original projectors.

We have to-day a membership as large or larger than that of the American Association, and during the past year our gain in membership has been more than double that of our sister organization.

Although the greater portion of our members are residents of New England, we include in our ranks representatives of water departments in twenty-five different States and Territories outside of New England.

The meetings of the past year have been well attended, and the papers presented at those meetings, with the informal discussion of topics relating to different branches of the question of water-supply, have been most instructive.

The three days' excursion to the Crawford House and North Conway in September was, to those who participated, an occasion of rare enjoyment, and one which will not be soon forgotten.

Most thoroughly do I believe in the encouragement of the social features of our meetings by these excursions, and by the informal gathering and dinner previous to our monthly winter meetings.

In no other way can so good opportunities be afforded for informal discussion, and for the interchange of ideas on all subjects in which we have a common interest.

At our first winter meeting in December, we listened to Mr. Freeman's paper on Fire Streams. The description of these experiments and the results deduced therefrom in the practical tables, constitute a most valuable contribution to the subject of hydraulics.

Mr. Forbes' paper on Algæ, with the accompanying discussion, is a valuable addition to our knowledge of a subject concerning which too little is known, and one which is of vital importance to many cities and towns, not only of New England, but throughout the world.

The short papers presented at the meetings of January and March covered a wide range of subjects pertaining to our daily work, and gave to us all facts of value, or questions for study.

Such has been the record of the year past. What shall it be during the year to come?

Let me briefly outline a few of the questions to the study of which we may well devote our energies.

The question of the quality of our water-supplies, and how that quality may be preserved or improved, is one which presents to view, in its different phases, numerous subjects, among which I may mention algæ and other growths in ponds and in ground water-supplies, and the treatment of water-supplies by filtration, aeration, etc.

A very careful study of the water-supplies of Massachusetts is being made under the direction of the State Board of Health, and we can very materially aid this work by personal observation, and record of the changes which occur in the quality of the supplies under our charge.

The comparative merits of cast iron and wrought iron and cement pipe has been in years past a fruitful topic of discussion, which has now, I think, been practically settled in the minds of the majority of our members; but the questions as to the minimum thickness of iron allowable in pipes, the best form and dimensions of pipe sockets, and of special castings, are still unsettled, and are well worthy of our careful study.

The preservation of the purity of our water-supplies is a subject which is assuming more and more importance as our country becomes thickly settled, and as a society we should use our influence to obtain such legislation as will prevent the pollution of streams used as sources of water-supply.

The prevention of waste has been discussed at a number of our meetings, but the subject has not been by any means exhausted.

In this question I have for a number of years taken a vital interest, as I believe that with many of our municipalities — perhaps not with Portland — the day is fast approaching, if it has not already arrived, when they cannot

afford to waste from 30 to 60 per cent. of the water drawn from the sources of supply. In the minds of some of our associate members there is no doubt as to the proper means of preventing this waste, and the best meter is supposed to be on exhibition in the adjoining room.

The careful consideration of these and all other questions pertaining to our daily work is the object for which our Association exists. In the eight years which have passed we have grown in numbers and increased our knowledge of the questions with which we are dealing from day to day, but increased knowledge and experience widens our opportunities for future advancement. Although our membership includes representatives of most of the larger works of New England, only about one-third of the total number are represented in the Association, and we have as many members in California as in Vermont.

In closing, I desire to thank you for the honor which you have conferred in placing me in the position which it has been my pleasure to occupy during the past year, for your courtesy and forbearance, and for your hearty coöperation.

Whatever of success has attended our meetings has been due to your earnest efforts and to the faithful and painstaking work of our Secretary and Junior Editor.

It has given me the greatest pleasure, and I think that my feelings are shared by every member, to have had the opportunity to testify in a slight manner my appreciation of the services which have been rendered to the Association by our faithful Secretary. To his unflagging interest and careful attention is due a great measure of the success of the Association, not only in the year past, but during all the years since the Association was formed.

He has done what he could; let every member resolve to follow his example, and the work so well begun will continue and expand until not only we ourselves, but every city and town in New England, will recognize the good work of the New England Water Works Association.

The Secretary read the following report: —

ANNUAL REPORT OF THE SECRETARY.

NEW ENGLAND WATER WORKS ASSOCIATION,
OFFICE OF THE SECRETARY,
NEW BEDFORD, MASS., June 3, 1890.

To the Members of the New England Water Works Association: —

GENTLEMEN, — Your Secretary herewith presents his report for the year ending June 1, 1890: —

On June 1, 1889, the membership of this Association was as follows, viz.: —

Active members	209
Honorary members	4
Associate members	64
Total	277

During the past year there has been a loss of 10 members, from the following stated causes: —

Deceased	1
Resignation	9

Sixty-eight applications for membership have been presented for your consideration, all of which have received favorable action.

The membership at this date is: —

Active members	257
Honorary members	5
Associate members	73
Total	335

The net gain for the year has been 58 members.

Your Secretary has made 402 collections, which may be thus itemized: —

From advertisements	$1,190 00
" initiation fees	354 00
" dues	800 00
" sale of transactions	142 98
Total	$2,486 98

All of which has been paid to the Treasurer.

Respectfully submitted,

R. C. P. COGGESHALL,
Secretary.

On motion of Mr. Morse, of Haverill, the report was accepted.

ANNUAL REPORT OF THE TREASURER.

Mr. Nevons submitted the following annual report: —

Dr. HIRAM NEVONS, *Treasurer, in account with the New England Water Works Association.* *Cr.*

1889.			1889.		
				By payments to: —	
June 17,	To amount received from R. C. P. Coggeshall, Secretary	$300 00	June 19,	F. L. Pratt, music	$51 00
			" 19,	W. H. Richards, money expended	19 25
" 19,	To amount received from A. S. Glover, retiring Treasurer	964 68	" 19,	Mellen House, three guests	24 00
			" 19,	Asa W. Gifford, services at exhibition	3 00
			" 19,	Jas. W. Henry, sundry dry goods	6 71
			" 19,	Henry F. Jenks, loan of chandelier	1 70
			" 24,	Wood & Hall, use of desk, etc.	3 50
			" 24,	Masonic Hall Ass'n, use of hall,	50 00
July 13,	To amount received from R. C. P. Coggeshall, Secretary	400 00	July 18,	W. Rogers & Co., stenographers,	80 00
			" 18,	Newton "Graphic," printing	4 00
			Aug. 24,	Collins & Fairbanks, badges	21 00
			Oct. 3,	Chas. W. Stacy, telegrams, etc.	7 81
			" 3,	A. S. Glover, 4 months' salary, junior editor	100 00
			" 9,	Edwin Dews, binding journals	12 50
			" 9,	Rockwell & Churchill, printing	6 50
			" 9,	" " "	9 00
			" 9,	" " "	180 88
Nov. 13,	To amount received from R. C. P. Coggeshall, Secretary	1,100 00	Nov. 16,	J. E. Denton, expenses at Fall River in connection with lecture on "engine"	60 00
			Dec. 10,	R. C. P. Coggeshall, services as secretary, six months' salary	150 00
			" 10,	R. C. P. Coggeshall, postage, telegrams, etc.	39 82
			" 11,	J. R. Whipple, Young's Hotel	14 50
			" 12,	F. L. Pratt, music	15 00

				" 12,	Hiram Nevons, stamps and envelopes	1 50	
				" 17,	W. Rogers & Co., stenographers,	10 00	
				" 24,	Prof. T. M. Drown, amount advanced for typewriting	15 00	
1890.							$886 67
				1890.			
				Jan. 8,	J. R. Whipple, Young's Hotel	$17 50	
				" 9,	Prof. W. T. Sedgwick, money advanced, work on diagrams,	2 00	
Jan. 13,	To amount received from R. C. P. Coggeshall, Secretary	400 00		" 9,	Heliotype Print. Co., redrawing diagrams and printing	20 00	
				" 9,	F. L. Pratt, music	15 00	
				" 21,	J. M. Whittemore, envelopes	10 00	
				" 29,	Mercury Pub. Co., printing, paper, and envelopes	122 87	
				Feb. 13,	J. R. Whipple, Young's Hotel	16 00	
				" 14,	F. L. Pratt, music	15 00	
				" 24,	Lewis Eng. Co., plates, etc.	8 75	
				" 28,	A. S. Glover, 4 months' salary, junior editor	100 00	
				Mar. 12,	J. R. Whipple, Young's Hotel	15 50	
				" 13,	F. L. Pratt, music	15 00	
				" 20,	W. Rogers & Co., stenographers,	65 30	
				" 31,	Rockwell & Churchill, printing	195 70	
				" 31,	" " "	28 00	
				" 31,	" " "	85 01	
				" 31,	Forbes Litho. Co.	48 75	
				Apr. 29,	Henry Guild & Son, badges	14 00	
				May 27,	C. H. Stacy, telegrams, etc.	15 44	
				" 20,	Rockwell & Churchill, printing	22 50	
				" 31,	" " "	209 54	
	Amount carried forward	$3,164 68			*Amounts carried forward*	$1,041 86	$886 67

Dr. HIRAM NEVONS, *Treasurer, in account with the New England Water Works Association.* *Cr.*

1890.			1890.			
	Amount brought forward	$3,164 68		*Amounts brought forward*.....	$1,041 86	$886 67
				By payments to: —		
			May 10,	Rockwell & Churchill, printing .	5 25	
			" 12,	Forbes Litho. Co.	22 50	
			" 29,	" " "	25 20	
			" 31,	Mercury Pub. Co.	73 38	
May 31,	To amount received from R. C. P. Coggeshall, Secretary	286 98	" 31,	R. C. P. Coggeshall, sundry disbursements	32 49	
			" 31,	R. C. P. Coggeshall, six months' salary, services as secretary..	150 00	
			" 2,	W. N. Hughes, envelopes	1 50	
			" 1,	A. S. Glover, four months' salary as junior editor.....	100 00	
			" 1,	A. S. Glover, p'd for postage, etc.	7 80	
						1,459 98
		$3,451 66	June 11,	Leaving a balance on hand, including accrued interest to date $1,129.30		$2,346 65
				On deposit in Nat'l City Bank...	$5 01	
				" " " Cambridge Savings Bank	100 00	
				" " " Cambridgeport Savings Bank..	1,000 00	
						1,105 01
June 11,	Accrued interest to date.....	24 29		Interest	.....	24 29
		$3,475 95				$3,475 95

HIRAM NEVONS,
Treasurer.

On motion of Mr. Morse, the report was accepted.

Mr. Andrews, on behalf of the Finance Committee, reported that the committee have examined the Treasurer's figures, and found the additions and the vouchers to be correct in every particular.

NOMINATING COMMITTEE.

The next business being the appointment of a committee to nominate officers for the ensuing year, on motion the President was instructed to appoint such a committee, and he appointed the following: W. M. Hawes, Hiram Nevons, G. E. Winslow, H. G. Holden, F. W. Wilder.

LOCATION OF NEXT CONVENTION.

The following telegram was read by the Secretary: —

"TORONTO, ONT., June 10, 1890.

"*To the President of the New England Water Works Association, care of William Hamilton:* —

"In obedience to a resolution of Council I have much pleasure, on behalf of the city, in extending a cordial invitation to the members of the New England Water Works Association to hold their annual convention for 1891 in this city.

"(Signed) E. F. CLARK,
Mayor."

The reading of the telegram was greeted with applause, and on motion of Mr. Wilder the President was directed to appoint a committee of five to take the matter of the place for holding the next annual convention in consideration.

Mr. HAWES. — I would suggest, if there are other members who have cordial invitations to extend to the Association, they submit them to this committee that is to be appointed, so the committee can have other places for consideration.

Subsequently the President appointed as the committee: Messrs. W. H. Richards, Charles K. Walker, F. W. Wilder, C. W. Morse, and G. A. Stacey.

The PRESIDENT. — The next business is the report of the committee appointed to consider and report upon the classification of rates, of which Messrs. J. C. Whitney, Water Registrar, Newton; W. W. Robertson, Registrar, Fall River; and George E. Batchelder, Registrar, Worcester, are members.

CLASSIFICATION OF RATES.

Mr. WHITNEY. — The general subject of water-rates has in some form been discussed at nearly every meeting of the Association, and the first object of your committee was to ascertain what action had been taken by previous committees upon the same subject. At the annual convention of 1887 the committee which had been appointed two years previously, and of which Mr. Howland was chairman, made a long and ably-prepared report on this subject, and perhaps a brief statement of its methods may not be uninteresting. A circular was sent to every water department in the United States and Canada, requesting them to send a copy of their rates, together with such suggestions regarding them as they might see fit to offer. In response to this circular four hundred and fifty

schedules were received, and these the committee then tabulated on large sheets containing twenty-three columns of subdivisions, covering all the principal uses of water. A careful study was made of the rates as tabulated, and it was found that such a difference exists in the systems on which the rates were based that a satisfactory comparison was impossible. The committee then, without special reference to any rates in force, recommended a rate on the first and each additional faucet or set-basin, but reported that it was impossible to make an annual rate on closets, bath-tubs, set-tubs, stables, and other uses, as reliable data as to the quantity of water used through these fixtures could not be obtained.

It seems to the present committee that the report of the committee of 1887 is the best that could be obtained by working on that line of investigation, and that it would be useless to attempt another investigation on those same lines. To the most of the water departments, water from the time it leaves the filter gallery until its delivery at the faucet means money; and it therefore seems proper that the rates for these fixtures should be based on the quantity of water used by them, if that quantity can be ascertained. This your committee is endeavoring to do by collecting data from fixtures and uses already covered by meters, and by setting special meters in cases not already covered. The Newton Water Board has purchased one hundred meters for this purpose, and an effort will be made to find out precisely the quantity of water used by these different fixtures. Care will be taken not to attempt to derive figures or facts from any meters which have been in use or been set, I mean, for a long term of years; and all special meters put on will be carefully tested before being attached. No figures from which satisfactory results could be obtained can be derived from these special meters until they have been set, I should say, nearly a year; and as this committee was not assigned the subject till the last meeting, and as the press of their work has interfered with their special investigations to some extent, they feel justified in asking for an extension of time until the next annual convention, at which time they believe a report can be made which will at least be interesting, and perhaps may prove to be of some value. (Applause.)

On motion of Mr. Richards, the committee was given further time in which to report.

Mr. C. W. Morse, Superintendent, Haverhill, Mass., then read a paper entitled "Comparative Merits of Public and Private Management of Water Works," which was discussed by Messrs. Fuller, Hawes, Cate, Whitlock, Allis, and Holden.

COMMITTEE ON BLUE-PRINTS.

On motion of Mr. Coggeshall, the President was requested to appoint a committee of three to collect, assort, and distribute blue-prints. The President appointed Messrs. Fuller, Allis, and Andrews.

The PRESIDENT. — I think it would now be well to take up one of the topics which have been suggested on the programme, and I will ask if there is any one of those which any member would like to have considered at this time. If not, we will proceed to the consideration of the first topic upon the list, which is "The effect of water-hammer upon distributing mains, and how remedied." We have one written paper upon that subject, which I will ask the Secretary to read.

THE EFFECT OF WATER-HAMMER ON MAIN PIPES, AND HOW REMEDIED.

BY

Y. C. Hancock, Supt., Springfield, Mass.

It is a well-known fact that the sudden arrest of a moving inelastic body causes a blow, or hammer. Water, being nearly devoid of elasticity, has the same effect as any moving solid material, if it comes in contact with an immovable substance, — it produces a hammer, in a greater or less degree, according to its weight and velocity.

That water-hammer, powerful enough to break water-mains, frequently occurs, is well known to most water-works officials. Water issuing from a small opening in a large water-main, under pressure, attains great velocity, as high in some cases as ninety miles an hour. Should this be shut off instantaneously a powerful blow would be produced, and perhaps a broken main would be the result.

A hammer that would cause two, three, or four times the normal pressure, would have as bad an effect as though the pressure were gradually raised to the same point; I am aware that it is claimed by many to be worse; if so, more the reason for guarding against it.

Moving water must be handled the same as any other incompressible body; if a train of railroad cars moving at great speed should come to a sudden stop, great damage would be done. So it is with moving water in mains; mechanical means must be provided for a gradual stoppage of the moving bodies in both cases, or a "smash-up" will be the result.

The effect of water-hammer being bad, it must be prevented, or confined within safe limits. But for all that has been said, I look upon the question of water-hammer as a good deal of a bugbear. The fact that the sudden stoppage of a moving body creates a blow does not necessarily imply that it must take place in a water-pipe any more than to a railroad train. Proper means must be provided in both cases to stop gradually.

No one would refuse to ride on a railroad because he would be hurt should the train run against a stone wall and stop instantly; but we are sure as it is possible to be that no such obstruction exists before we start.

So it should be with a system of water works; every precaution should be taken to prevent accidents; all gates and appliances should and must be made to shut off the moving streams slowly, to insure safety. If the works are built in a thorough manner, and operated as all works should be, no great trouble will be had from water-hammer.

Accidents will happen in the future as they have in the past; all we can do is to reduce them to a minimum.

The President. — The paper is now open for discussion. It seems as though some of you must have had some experience with water-hammer. I will call upon Mr. Richards.

Mr. Richards. — Mr. President, I don't know that I have had very much experience in curing water-hammer. We have one once in a while, but nothing very serious. Of course, when a valve is closed suddenly, water-hammer

is produced, and the effect of it is greatest near to the gate or to the valve that is closed, and it tapers off the farther you go away from that point, so I have suggested several times putting on a relief valve. If you can ascertain where the water-hammer is likely to occur, it seems to me that a good way would be to put on a relief valve, and let off a little water and relieve the main of the shock. I have never tried it, because I have always succeeded in stopping it some other way; but I think that might be tried very effectively.

Mr. ANDREWS. — I had occasion to test where there was about 60 pounds pressure on a hydrant; I put a recording gauge on there and then shut off the hydrant as rapidly as I could, — I think it was a Chapman hydrant, — and I found the water-hammer went from 60 to 80 pounds. I don't see how that could do very much damage, 80 pounds pressure. There was 60 pounds pressure, and it went up to 80. I think there is a good deal more alarm than is necessary on this point. Of course, I can see where there may be a case, like on a railroad, where they have one of those valves that shut down very rapidly; I don't know what that kind is called, it shuts down with a lever; in that case I can see how a great deal of water-hammer might be produced; but with any ordinary valve hydrant, I don't see how any such large amount as they tell about can occur.

Mr. STACEY. — I think the danger from water-hammer is something that pertains to the length of the pipe, and the velocity of the water through it. If you take a hydrant right off a large main, and you suddenly shut it, you are only arresting what water is coming from the main into the pipe. If you are running a 6-inch pipe down a mile, and you open the hydrant wide on that end and then shut it down suddenly, you will find you are going to pack the water much tighter than if there was only twelve feet of pipe. I tried an experiment once on four or five hundred feet of 6-inch pipe, and in shutting the hydrant down from 97 pounds I could very easily get 200. We tried it, also, with shut-off nozzles, and we could get 140 pounds pressure there; it went from 97 to 140 the slowest way we could close the nozzle. Of course we had the elasticity of the hose to take up some of the shock. Now, up on the main street under the same conditions we wouldn't have got over 15 pounds additional pressure. So I think the danger from water-hammer, with the thickness we allow for pipe now, is almost wholly on a long main where the outlet is sufficient to create a high velocity, and then the flow of the water is suddenly arrested. But with any ordinary gate, unless you work pretty quick, I think you would very seldom run the pressure up to the point that the pipe is tested at before it leaves the foundry.

Mr. CLARK. — This subject came up before the Association a few years ago, and I took the liberty to make a few remarks about it at that time, and as the matter is up again, I may take the liberty to refer briefly to the facts that I stated at that time. We supply four railroad stand-pipes. Formerly we had two breaks, one on a 12-inch pipe and one on a 4-inch pipe, on account of the sudden shutting off of the water; but we have an arrangement at the present time which relieves us from the apprehension of any danger. It is a peculiarly constructed valve, partially automatic, so that a plunger in the cylinder rises up with the supply of the water. This plunger is perforated, and the perforations are, perhaps, half an inch in diameter, or smaller than that, making bare one hole after another till it is all open. It takes about three minutes to open it

and three minutes to shut it. Since we have had this arrangement, the device of one of our water commissioners, we have had no trouble, except in this way, that there is a reduction of the pressure whenever the railroad is taking water. Two years ago, one Sunday, the motors in two of the churches were stopped by the pressure being reduced from 85 pounds down to 50 pounds. There doesn't seem to be any particular shock. I expected there would be a rupture of some of the joints, but the arrangement seems to work perfectly satisfactory. And the same gentleman has furnished similar constructions for Westfield, and I think for Holyoke, and they work admirably.

The PRESIDENT. — If I understand correctly this valve lets the water on to the stand-pipe very slowly, and it is impossible to shut the water off quickly.

Mr. CLARK. — They can't shut it off quickly. It takes from a minute and a half to three minutes.

The PRESIDENT. — Mr. Winslow, of Waltham, gave a description last winter of a plan of using a safety-valve on the branch to the stand-pipe, attaching it close to the stand-pipe, to relieve the pressure in case of a sudden closing of the valve.

Mr. CLARK. — I would like to ask one question in connection with this subject which is not perfectly germane to it, but which perhaps would not be out of order at this time. I would like to ask any one of the members how he fixes the rate for railroads? Do you meter every railroad you supply, or in what way do you arrive at a proper rate for a railroad?

The PRESIDENT. — There is a question for water registrars and superintendents to answer.

Mr. HYDE. — We supply two stand-pipes in one round-house through 4-inch meters.

Mr. HAMILTON. — I think the only way to supply water to a railroad is by meter. Certainly it is the fairest way, and the only way in which you can get the actual amount used. We supply in Toronto through meters, 6-inch meters.

The PRESIDENT. — In Boston the railroad supplies are taken through meters in all cases, and where it is practicable they are required to put in storage-tanks, and in all other cases we now oblige them to put on a safety-valve such as Mr. Winslow described last year.

Mr. ANDREWS. — We run a 1¼-inch pipe into the tank, and meter that.

The PRESIDENT. — That is the same as we do.

Mr. LUSK. — In Washington we are supplying two railroad companies through meters and tanks as you describe. We find it very satisfactory, and the railroad companies find it much more satisfactory than any schedule rate. Our meter rate is only three cents a thousand gallons.

The PRESIDENT. — There is a great advantage to the railroad companies in supplying from a tank. With a tank they are able to have the full delivery of a 6-inch pipe, while even a 6-inch meter will deliver but a very small proportion of the full flow of a 6-inch pipe.

Mr. STEBEN. — I don't know that any one has had much more trouble than we have had at Brockville, Ontario. We have been supplying the Grand Trunk for five years. They used to take it direct by opening a 6-inch valve, and every time they shut off so quickly, our pumps would come almost to a stand-still. So I advised our company to put up a tank; but they thought they wouldn't like to do it,

— they didn't care to spend any money on it; but finally, about six months ago, the back pressure was so great one day that it broke one of the foundation stones of the engine in the engine-house. You can imagine what a back pressure there was. I told the directors they had better do something at once, or else there would be a very serious result; and at last they let me put up a tank, and I went to work and put up a tank that holds 20,000 gallons. It is fed with a 2-inch pipe, with a self-acting valve on top; and now the railway company takes all its water from the tank, and we haven't had any trouble. It works most satisfactorily.

Mr. CLARK. — Will the gentleman please state the dimensions of the tank.

Mr. STEBEN. — The tank is 14 × 15, and holds 22,000 gallons. It cost $500.

Mr. HAMILTON. — I have had some little experience with water-hammer, due to the sudden closing of valves. If you get a slow-closing valve, there is no danger of water-hammer. We have had pipes broken from a hoist, and I thought it would be a good plan to put an air-chamber somewhere near the hoist. That is a question we have talked over several times, putting an air-vessel somewhere close to the hoist, so it would take the concussion. There is no danger if the valve closes slowly, and I think the only way to avoid the danger is to close the valve slowly, or else put on an air-vessel, which is a plan I advised some time ago.

Adjourned to Thursday morning.

MORNING SESSION.

THURSDAY, June 12.

The PRESIDENT. — The convention will please come to order. The first business being the election of officers, we will hear the report from the committee appointed to nominate officers for the ensuing year.

Mr. Hawes, for the committee, presented the following report: —

President. — Albert F. Noyes, City Engineer, West Newton.

Vice-Presidents. — George P. Wescott, Treasurer Water Company, Portland, Me.; Charles K. Walker, Superintendent, Manchester, N.H.; F. H. Crandall, Superintendent, Burlington, Vt.; P. Kiernan, Superintendent, Fall River, Mass.; William B. Sherman, Civil Engineer, Providence, R.I.; W. H. Richards, Superintendent, New London, Conn.

Secretary. — R. C. P. Coggeshall, Superintendent, New Bedford, Mass.

Treasurer. — Hiram Nevons, Superintendent, Cambridge, Mass.

Senior Editor. — F. H. Parker, Commissioner, Burlington, Vt.

Junior Editor. — Albert S. Glover, West Newton, Mass.

Executive Committee. — Frank E. Hall, Superintendent, Quincy, Mass.; Dexter Brackett, Superintendent, Boston, Mass.; Charles W. Morse, Superintendent, Haverhill, Mass.

Finance Committee. — H. F. Whittier, Registrar, Lawrence, Mass.; G. E. Winslow, Superintendent, Waltham, Mass.; F. A. Andrews, Assistant Superintendent, Nashua, N.H.

The report of the Nominating Committee was accepted.

Mr. John C. Kelley, President of the National Meter Co., objected to the election of Mr. Glover as Junior Editor, on the ground that his present occupation as selling agent of the Hersey Meter Company disqualified him from holding office in the Association.

Mr. HYDE. — I understand it requires unanimous consent in order to have a ballot cast for all the officers. In order to test the sense of the Association, I move that the Secretary be requested to cast the ballot of the Association for all the officers reported by the Nominating Committee, except for the Junior Editor, and that the convention ballot for him separately.

The motion was adopted, and the Secretary cast the ballot as directed, and the officers as reported, with the exception of Junior Editor, were declared elected.

The PRESIDENT. — With the consent of the convention I will appoint the following committee to collect, sort, and count the ballots for the Junior Editor: Messrs. Fuller, Gould, and Eaton.

The ballot was then taken and resulted as follows: —

Whole number of ballots	53
Albert S. Glover	44
Dexter Brackett	2
J. A. Gould	2
No	1
Any active member	1
F. P. Stearns	1
Charles G. Walker	1
F. L. Fuller	1

And Mr. Glover was declared elected.

Mr. STEARNS. — The question has been raised about associate members holding office, and attention has been called to the fact that there is no provision in the constitution by which an active member upon leaving active service upon the water works becomes an associate member. I believe that the principle is right, that in a general way an associate member should not be an active member, or at least a man who has taken a position in which he should be an associate member should not continue to be an active member. On the other hand, there being no provision of that kind, I voted for Mr. Glover, for I thoroughly believe in him as a man, and believe that he is the best man for the place. Now, I am not sufficiently familiar with this matter to say what should be done, but I would move the appointment of a committee to consider the advisability of a change in the constitution with reference to having an active member become an associate member at such a time as he comes into such a position that his relationship to the Association should change, that committee to report upon the subject — I am making my motion rather long — at the next annual meeting.

The PRESIDENT. — As I understand the motion, it is to the effect that a committee of three be appointed by the President to consider the advisability of amending the constitution with reference to the standing of the active and associate members, this committee to report at the next meeting, and to report such changes in the constitution as they deem advisable, with reference to this point.

The motion was adopted, and the President subsequently appointed the following-named gentlemen as the committee: Messrs. Stearns, of Boston; Billings, of Taunton; and Coggeshall, of New Bedford.

Mr. HAWES. — I don't want the constitution changed, for I go out of office next year, and I want to die an active member of this Association. (Laughter.)

The PRESIDENT. — If there is no further business we will proceed with the papers for the morning, and I will call first upon Prof. William T. Sedgwick, of the Massachusetts Institute of Technology.

Prof. Sedgwick then read a paper entitled "Surface Water for Drinking Purposes."

The paper was discussed by the President, Messrs. Allis, Fitzgerald, Bayles, Nevons, Learned, and Hawes.

The PRESIDENT. — The next article upon the programme is a paper by Mr. Locke, on "Notes made in Holland in 1877;" but he not being present, I will ask the Secretary to read his paper.

Secretary Coggeshall thereupon read the paper of Mr. Locke, of North Adams.

Supt. P. F. Crilly, of Woburn, then read a paper entitled "Why I Favor the Use of Cement Pipe." The paper was discussed by Messrs. Nevons, Walker, Dennett, Allis, Steben, and Hancock.

Adjourned to 2 o'clock P.M.

AFTERNOON SESSION.

At the afternoon session, Mr. A. Fteley, Chief Engineer of the New York Aqueduct Commission, gave a very interesting and instructive talk upon the new Croton Aqueduct, beautifully illustrated by lantern views, which was enjoyed by a large number of friends of the members, as well as by the members themselves.

At the close of Mr. Fteley's address the regular business of the Association was resumed. The President called upon the committee appointed to select a place of meeting for the next annual convention, to report.

Mr. RICHARDS. — The committee have given this matter a good deal of thought, and consulted with all the members they have had opportunity to speak with, and they recommend that the next annual convention be held at Hartford, Connecticut, and that the Executive Committee be empowered to select the place for holding the fall meeting. Regarding the invitation from the Mayor of Toronto, your committee would offer the following vote: —

Voted, That the Secretary is instructed to transmit the thanks of this Association to the Mayor of Toronto for the courteous invitation to hold the convention of 1891 in that city.

Voted, That whereas a clause of the constitution restricts the holding of regular meetings to New England, the invitation be declined.

On motion of Mr. Fitzgerald, the recommendation of the committee, that the next annual convention be held at Hartford, and that the Executive Committee be empowered to select the place for holding the fall meeting, was adopted.

On motion of Mr. Billings, the votes submitted by the committee were adopted.

Mr. FITZGERALD. — I move that the thanks of the Association be extended to Mr. Fteley for his courtesy and kindness in coming here and giving us this very interesting address to-day.

The PRESIDENT. — It is with great pleasure I rise to put that motion. I per-

sonally appreciate the great favor Mr. Fteley has done, for I know he is a very busy man, and he has put himself to a great deal of trouble to come here and give us the very pleasant entertainment we have had.

The motion was adopted with applause.

Mr. Fteley expressed his thanks for the courtesy of the vote.

At the request of the President, Mr. John A. Gould, Jr., assistant engineer, Boston, Mass., then read a paper entitled "Recording Gauges."

Mr. G. A. Roullier, superintendent, Flushing, N.Y., then read a paper entitled "Water Meters, the Advisability of their Use."

Mr. Roullier's paper was discussed by Messrs. FitzGerald, Billings, Chace, Whitney, Walker, Ringrose, Allis, Whitlock, Fuller, Crandall, Hamilton, Hawes, Woodruff, Filburn, and the President.

On motion of Mr. Hawes, the Secretary was instructed to convey to the Mayor and city government of Portland the thanks of the Association for the use of rooms in City Hall; and the Secretary was also instructed to extend to the Portland Water Company the hearty thanks of the Association for the numerous courtesies received at its hands.

Adjourned to 7.30 P.M.

EVENING SESSION.

The PRESIDENT. — The Secretary has some applications for membership, which we will act upon at this time.

The Secretary read the following list of applicants for membership, which he stated had been approved by the Executive Committee, and by them recommended to the Association for election: —

Resident Active.—Theodore H. McKenzie, Superintendent, Southington, Conn.; C. M. Brainard, Superintendent, Skowhegan, Me.; W. H. Childs, Superintendent, Manchester, Conn.; D. N. Clark, President Water Company, Portland, Me.

Non-resident Active. — B. D. McConnell, Superintendent, Montreal, Quebec.

Associate Members. — Smith & Anthony Stove Company, Water-Works Supplies, Boston, Mass.

On motion of Mr. Fuller, the Secretary was instructed to cast the ballot of the Association for the above-named applicants for membership, which he did, and they were declared elected.

The Secretary read the following letter: —

PORTLAND, ME., June 11, 1890.

Mr. R. C. P. COGGESHALL, *Secretary N.E. Water Works Association*: —

DEAR SIR, — I have the honor to apply for a change of status from associate to non-resident active member. I have no reason for desiring a classification primarily designed for those who deal in water-works supplies, but shall value membership for the privilege of papers and discussion.

While it is true that I am the president of a company extensively engaged in the manufacture of pipe, I am also an engineer with an active professional interest in most of the subjects covered by the work of the Association. My standing as a sanitary engineer is well established, and it will give me pleasure to be as active in the duties of membership as my opportunities may permit.

For these reasons I ask that my status be changed from the commercial to the professional.

Respectfully,

JAMES C. BAYLES.

The SECRETARY. — It is no more than fair to Mr. Bayles to state that he is a very prominent man in his profession, and is the Vice-President of the American Association of Mining Engineers, and his reputation is well known. The Executive Committee has voted to recommend to the Association that Mr. Bayles' status of membership be changed in accordance with the request contained in his letter.

The recommendation of the Executive Committee was unanimously adopted by vote of the Association.

The President called the attention of the members to the blue-prints which had been collected and assorted into sets by the committee, and were ready for distribution. After they had been distributed the President invited any member to open the discussion upon, or to bring up for discussion, any of the subjects which has not yet been considered by the convention.

WEIGHT OF MAIN PIPE.

Mr. ALLIS. — There has been some discussion in my town with regard to the size of pipes, and I notice it is one of the topics upon our list. I should like to hear what some of the gentlemen have to say upon that.

The PRESIDENT. — You hear the suggestion of Mr. Allis, that he would be pleased to hear from any member who can give any light upon the subject, "What is the minimum size of mains allowable for fire supply?" I might say I jotted that topic down myself, feeling that in a great many places mains are used to-day which are not as large as they should be; or, perhaps, I might better say, are so small that the authorities will in a few years be likely to wish they had been larger. My attention was drawn very strongly to this point by a trip which I made during the winter, visiting cities as far south as Baltimore. I found that the city of Baltimore, for instance, is laying long lines of 4-inch pipe. I think they laid during the last year, if I remember correctly, some five or six miles of 4-inch main, and a very large proportion of their mains are of that size. If cities of the size of Baltimore are to-day laying mains of that size, it would seem to me that the topic has not been exhausted, so but what some people, at least, might profit from its further discussion. For myself, I do not believe that 4-inch mains should be used in any cases where the pipes are to be used for fire supply, that is, for hydrant supply, and that 6-inch mains are in a great many cases used to too large an extent, where the mains are of extreme length. Of course a 6-inch main will supply one or two hydrants, but when you get four or five on a long length of 6-inch pipe, and attempt to supply all the hydrants from that at one time, you will probably fail to get an adequate supply of water. I simply state these facts, and will ask some of the other gentlemen to continue the discussion.

Mr. WINSLOW. — I have had a little experience within the last month with regard to a pipe which was in circulation in the yard of one of our manufactories in Waltham. They had a 4-inch pipe in circulation, and had their hydrants on

it. The manufactory is the Waltham Bleachery. Just how much they are doing of that sort of business I can't tell, but they get off about eighteen tons of cloth per day in the way of finishing, and so forth, and the consequence is there is a good deal of money at stake there. Mr. Freeman came out there to inspect the works a while ago, and wasn't really satisfied with them. He tried the city pressure on the mains, and tried the fire streams to see how many he could get. I believe with four streams he brought the pressure down to 34 pounds; the static head there was 77. Two-inch hose was what they used, and 1-inch nozzles. Of course there was a pretty large friction on the hose, which would naturally keep the head in the mains comparatively high. He tried it every way to see where the trouble was, and the final conclusion was they had better put in a 6-inch pipe. The distance around the circulation was about 1,500 feet. After he got it completed I had the curiosity to know what they could do there for fire service, and I broached the subject to the superintendent and the master mechanic, and the consequence was they tried the experiment. With four streams they got 60 pounds on the main; they were taken from hydrants at different intervals around the yard, and to get down to 34 pounds we put on eight streams. Then we put on the fire-pump, — and the fire-pump in the old service was good for not over four streams, — and we played eight streams and got 38 pounds. We put on the fire-pump and the city water together and got twelve streams, and the pressure then was maintained at 43 pounds. The gauge was put on to a hydrant which was not in use, and these streams were taken from other hydrants about the yard. There were seven hydrants in use in this 1,500 feet. The conclusion was that a 4-inch pipe under those conditions wasn't the thing, but a 6-inch pipe was; and in order to get more streams than that a larger pipe would be still better. In my opinion, in laying mains through a town or city, if you are going to use them for hydrant service a 4-inch pipe is not sufficient, and at least a 6-inch pipe should be used.

Mr. FULLER. — I think there is no doubt that 6-inch pipe is as small as will furnish a good fire stream, that is, unless it is a very short length, for one hydrant possibly. Four-inch pipe will answer for domestic use, and is oftentimes very serviceable in connecting dead ends so that the circulation is maintained; but where fire protection is needed, I think that 6-inch pipe is, without doubt, as small as should be used.

Mr. WINSLOW. — I may speak of a case where several years ago I tried to get an additional 6-inch main laid, where there was a 4-inch laid to supply a settlement in the back part of the village. I told them that for fire service a 4-inch pipe was no good, but they thought there never would be any fire there. The 4-inch pipe ran nearly a mile. The people were satisfied with it; they got all the water they wanted, and they didn't think it necessary to put in the additional main through another street to maintain the circulation or get an increased supply. A very short time after that a large boarding-house caught fire in the L, and although the main part of the house was saved, the L was completely burned. They took the hydrant that was where the junction would have been if we had had the other pipe connected, and without any steamer to help them they couldn't get the stream over the roof of the L. By putting the steamer to it, they could get one very good stream with 1⅛-inch nozzle. When they attempted to use two streams they couldn't do anything at all, and the con-

sequence was most of the fighting was done with one stream. I don't imagine they got over 220 gallons a minute when they were putting their engine to its best, and while doing that a farmer living in a house near by went into his kitchen to get a drink of water, but when he opened the faucet, instead of water coming out air went in. Inside of four weeks after that fire happened, there was a petition before the selectmen to have a 6-inch pipe put in the other street; and it was put in.

Mr. GOULD. — Some time ago I had occasion to see what 10,000 feet, or about two miles, of 6-inch pipe would deliver, and I found it to be one fair fire stream, or 225 gallons per minute, through a 4-inch meter. I have come to the conclusion that it is not safe to put a Lowry hydrant, to which four steamers can be attached, on a 6-inch dead-end pipe more than 150 feet from the main pipe. That may seem to be a pretty hard statement, but that is the conclusion I reach. A 6-inch pipe will only supply eight fire streams from the dead end of a pipe 150 feet in length. We have about 45 pounds pressure.

Mr. WHITLOCK. — I would like to ask Mr. Gould if it wouldn't depend somewhat on the head. I think in our case we would have no trouble in supplying 500 feet, if not 1,000. Our heads run very easily to about 250 feet.

Mr. GOULD. — I said in our case we have about 45 pounds pressure.

Mr. WHITLOCK. — I didn't hear that.

Mr. ALLIS. — We have a very complicated system in our town, and I ask some of these questions because I want to find out what experience you have had. They began in the city of Malden, when it was a small town, by laying small pipe. There are streets three or four thousand feet long, with side streets leading from them, and in these streets are 4-inch pipes with hydrants about every 500 feet, and I find that occasionally when I blow them off to clean out our pipe the people upon the street will want to know why I shut the water off without giving them any notice. It about empties that pipe. It has occurred to me that I should put in a good deal larger pipe than some recommend, and where I have a large district, rather outlying, our town being so scattered, I have made a regular plan of what I want, and I calculate to put a 12-inch pipe right around the whole city, and cross it with 8-inch in large sections, and then cross with six, giving my 6-inch pipe not too long a distance without coming into an eight, and in that way I intend to get more pressure on the smaller pipes. I have found where I have now a large section under the 8-inch pipe that when I have a pressure at City Hall of 82 pounds by gravity, if I go down to Edgeworth, which is five feet lower, I have only 46 pounds. The draft from the 8-inch pipe reduces the pressure that much. So we have to allow not only for the fire streams, but for the draft of the city, which is sometimes very great on any section. My idea is to put in good deal larger pipe than some think necessary, to get the best effect, taking into consideration all these things. So far as my experience goes, I find if we have a 4-inch pipe on a street with houses on it, and side streets leading off from it, the fire protection is practically nothing; and I only use it now in the outskirts, and in small courts, and to get circulation. I am glad to know that, so far as appears from the sentiment of the members here, I am pretty near right in my opinion in regard to the matter.

Mr. WALKER. — We don't lay anything less than 6-inch pipe anywhere. If

you had 800 feet of 6-inch pipe, and you had at one end a 12-inch and at the other a 14-inch, couldn't you supply four hydrants?

The PRESIDENT. — What kind of hydrants?

Mr. WALKER. — Common post hydrants, with two nozzles.

The PRESIDENT. — I should say yes.

Mr. GOULD. — What is the length of the 6-inch pipe?

Mr. WALKER. — About 800 feet.

Mr. ALLIS. — What is your pressure?

Mr. WALKER. — The pressure is 62 pounds.

Mr. GOULD. — It would be risky.

Mr. WALKER. — The reason I asked the question is, I put in an 8-inch to connect those two pipes. (Laughter.)

Mr. WINSLOW. — I guess you are on the safe side.

The PRESIDENT. — What is Mr. Hawes' opinion?

Mr. HAWES. — I never saw any pipe too large yet, but I have seen a great deal too small.

The PRESIDENT. — I don't know but a good many of you may have heard Mr. Jones tell the story about his advice to the engineer who came to Boston at the time the Milwaukee works were built to consult with reference to the sizes of their mains. Mr. Jones, who was then the Superintendent of the Boston works, gave this advice, that they should lay as large mains in all cases as they could possibly afford; and, in his opinion, it would not be a great many years before they would wish they had put in larger ones. I guess that would be the opinion which would be given by a good many of us, judging by past experience, although, of course, in some cases, the interest on the original cost might enable them to relay their pipes. We have relaid a great deal of our pipe in Boston, simply for the purpose of enlarging it for fire supply. Many of the pipes were laid about forty years ago, however, and I suppose, according to Mr. Crilley's statement, they had outlived their usefulness. Their capacity had been very much reduced from what it was originally, for the pipes were badly tuberculated. I have cleaned by a scraping process, about 15 miles, 6 to 12 inch pipe, and the delivering capacity of the 6-inch pipe was increased by the cleaning process about 300 per cent., by actual measurement.

Mr. WALKER. — Was that originally coated pipe?

The PRESIDENT. — No, it was not originally coated pipe. The 6-inch pipe has a coating of tubercles from one-half to three-quarters of an inch thick. I expect that the tubercles will re-form, but the cleaning was done comparatively cheaply, costing about 15 cents per foot; and if we only had the advantage of it for three or four years, it would pay rather than to relay the pipe for that time.

A MEMBER. — I would like to ask what process is used in scraping?

The PRESIDENT. — The scraper was invented by Mr. Sweeney, of Fitchburg. The scraper consists of a centre core of spiral spring to give flexibility, and the whole machine is between three and four feet long. At the rear are two rubber pistons, one about 18 inches or two feet in front of the other, fitting tightly the size of the pipe to be cleaned. The rubber pistons are made in sections, or attached to sections of iron, and these are held by spiral springs to allow them to spring back to pass the service cocks. In front of the pistons are scrapers arranged in two sets, one in front of the other. A section is cut out of the

main, and this scraper inserted in a section of the pipe, the pipe then put together with flange sleeves, and the pressure turned on behind the pistons or the scraper. The length of the run would only be limited by the position of the gates. I didn't attempt to run it through any of our gates. I don't know but what it would have gone through, but usually it was not advisable to shut off for longer sections, in that part of the city where the pipes were cleaned. The pipe was cleaned in sections of from three hundred to fifteen hundred feet in length. I should think about 800 feet would be the average. Of course, where the pipe was cut at the outlet end the scraper would bring through with it the accumulation which it scraped off of the pipe. In some cases it was run through twice, but it was found that once running through would remove almost all of the accumulation.

Mr. COGGESHALL. — Did you find that the taps protruded into the main in any case so the machine would not pass?

The PRESIDENT. — No, sir. The only thing that ever stopped the machine was where, when the pipes were originally laid, the lead had run through into the pipe. I did find cases where very sharp bends had been made in the pipe, to pass some obstruction in the street that the scraper would not pass. I might add that the two pistons which were attached to the machine were for the purpose of allowing it to pass branches, either at hydrants or at street corners. Of course, if there was simply one piston, if it stopped at a branch, the water would pass around, and the machine would stop there. The course of the machine was followed by watching at the hydrants. The instant it passed a hydrant we had the pressure behind it; and we could also locate it by the services in the houses.

Mr. FULLER. — How fast did it travel?

The PRESIDENT. — It would travel about as fast as you would walk, sometimes faster. In some cases it would catch on an obstruction, or an accumulation of rust would pile up in front of it, and it would stop until some water passed by it and carried the obstruction away, and then it would start again. Sometimes by shutting the water off and letting it on again the scraper would start, but generally it would go along without any trouble. Of course, after we had had experience in the operation of it we could do better than at first.

Mr. FULLER. — Did it require a different size machine for different sizes of pipe?

The PRESIDENT. — Yes; a different size machine. A similar machine was used in Halifax previous to our using one in Boston, and we tried some experiments with the Halifax machine, which was used by Mr. Keating, the city engineer there. But his machine is made more rigidly. The backbone of the machine, you may say, is a solid pipe with one hinge, I think, in the centre; while ours, being made of a spiral spring, you can almost double the two ends of it together. At the same time it has sufficient stiffness to clean and take off all the accumulation on the inside of the pipe.

Mr. ALLIS. — I would like to ask what pressure you had, and what you think would work best?

The PRESIDENT. — Ordinarily about 40 pounds. With pressures less than 30 you would probably have trouble in using it, that is, on a 6-inch pipe. When you get on to the larger sizes, of course you have more power, although most of the pipe that we cleaned was 6-inch.

Mr. WALKER. — I understand Mr. Nevons has had some experience.

The PRESIDENT. — We should be very glad to hear from Mr. Nevons.

Mr. NEVONS. — A few years ago I received Mr. Keating's report, in which was contained a description of his hatch-boxes, and it seemed to me his apparatus was something which was extremely practical for cleaning out pipes. At any rate, he presented the matter in such a way that I was much interested in it, knowing we had lots of pipe which had never been coated, and I went down to Halifax and saw the machine, and had a long talk with him, and saw his arrangements for inserting the machine into the main, and got his price for using the machine. I thought the price was rather high, and when I came home and reported to our Water Board, they also thought it was too high, and that it was too much of an experiment to go into. I had quite a little correspondence with Mr. Keating, but we couldn't come to terms, and the matter was dropped until they started over in Boston, when the parties came over to see us, and we made arrangements with them to send one of the machines down. We had a special case we wished to try it on; it was a 6-inch main about 1,000 feet in length. The man who came to see us said he wanted to send us a little different machine than they were using in Boston, and as soon as they got it ready they would send it along. Finally he sent it, with directions how to use it. I wrote back to him I should not use the machine till he came down himself, for I wanted to have all the conditions right, and to give it a good, fair trial; and I received a letter from him saying he and his partner would come down on such a day. I had arrangements all made to cut the pipe, and as soon as they came we proceeded to business. I asked him how much pressure we must have, and he said he would like to have forty pounds. We gave him forty-five pounds. We cut the pipe at the lower end, took out a piece, and were prepared to take care of the water that came through with the machine. While this was going on quite a crowd of people collected to see what we were about, and we told them we were going to clean out the pipe; and quite a delegation was there by the time we got ready. We had pretty hard work inserting the machine into the pipe, but finally we got it in and closed up the pipe, and stationed a man at the gate, and the machine man told us we would have to run to get down to the other end. I said to the man at the gate: "You hold on now till I get down there, and when I get down there I will wave my hand, for I want to see this machine come through." I think we got ready to turn the water on just about 2 o'clock. Well, we went down, and I gave the man the motion to turn the gate, and we waited fifteen minutes. The machine man said: "I don't know what the matter is." Said I, "I don't." So we motioned to the man to close the gate again, and went up there. We asked him if he did so and so, and he replied, "Yes, I commenced opening the gate slow, and turned it till it was wide open." — "Well, I think you had better open it a little quicker," said the machine man. And I told him to wait till we got down there, and we started and went down to the lower end and gave the signal again. He turned the gate as fast as he could, and we waited, but saw no signs of the machine or water. We fooled around with it till four o'clock, and I told him I thought that was about as long as we could afford to shut off; we had two hydrants upon that territory, and we would have to take out the machine. He said he couldn't understand it, and he wanted to see the pressure was right; so I put the pressure gauge on and showed

him forty-five pounds. He said he had got to take the train for home, and I told him I had got to take the machine out so we could turn the water on. (Laughter.) So we went to work and got the machine out; it hadn't moved but about four inches. We cut it out, and after we closed up and let the water on I took it down to the shop very carefully and set a man to work on it, told him not to jar it any more than he could possibly help, and split the pipe right open lengthwise, and it was the worst-looking sight I ever saw. I don't think seventy-five pounds would have carried it through. The man came down to see me a few days after I cut it out, and I showed it to him. He said it worked well over in Boston, and he didn't know what in the world was the matter with it. I said, "I didn't suppose you were coming over here to try any experiments." I haven't heard from him since.

The PRESIDENT. — That was the Fitchburg machine?

Mr. NEVONS. — Yes, the same machine. I may say that in inserting this machine, which was tapering, it took two men with a crowbar to force it in. I asked him if that wasn't going in rather snug. He said, "No, that is just right." (Laughter.) Speaking about Mr. Keating, I remember that their supply had been so much reduced by the filling up of the pipes that they were talking about putting in a new main, but after he ran this machine through there was no necessity for it at all; they had sufficient capacity in their supply main for the city. I saw him not a great while ago, and I asked him how it worked, and he said that about once in two years he ran the machine through. His hatch-boxes are all made as a special casting with a cover, and all he has to do is to take the cover off and put the machine in, and he has another one at the lower end. He says it is no trouble at all to work it, and he has had complete success with it. It is altogether a different machine from this one.

The PRESIDENT. — He uses his more particularly on his large mains. He has cleaned some small pipe, but I think his machine is more applicable to large mains, and he uses it on them with great success; there is no question about that. He uses it where he can run it, I believe, for one or two miles, putting it in at one end and taking it out at the other.

Mr. NEVONS. — One gentleman spoke about the effect of hitting against a tap or screw-cock in the main. Mr. Keating showed me an inch screw-cock that this machine cut right off, it is so rigid. In this Fitchburg machine the scrapers will spring back, and the moment they pass an obstruction they will spring into position again.

Mr. WHITLOCK. — I would like to ask if the scrapers on that machine are movable or stationary ?

Mr. NEVONS. — Stationary.

Mr. WHITLOCK. — They are rotary, are they not ?

The PRESIDENT. — No, sir.

Mr. WHITLOCK. — I would like to ask how sharp angles you went around with the scraper ?

The PRESIDENT. — We never attempted to pass any very sharp turns.

Mr. WHITLOCK. — Should you say it would go through a 45-degree curve?

The PRESIDENT. — I think it would. It may have gone through, I think, in our mains a great many sharp turns in the pipe. When it stopped was the only times we found where the obstructions were.

There is one topic on our list upon which a short written paper has been contributed, "Depth of Lead necessary in Pipe Joints," and I will ask the Secretary to read it.

The Secretary read the following communication from Mr. J. C. Hancock, Superintendent at Springfield: —

DEPTH OF LEAD NECESSARY IN PIPE JOINTS.

In laying cast-iron pipe in Springfield, we use from one and one-half to two inches depth of lead for joints.

We have two systems, — the high service, with a static pressure of 135 pounds per square inch; and the low service, with about 35 to 40 pounds pressure.

The greater depth of lead is used on the high service. I have had some joints on this system blow out, where only one and one-half inches were used. I should not consider it safe to use less than two inches of lead on our high service, and in some cases where we lay pipe in dangerous places, as little yarn as possible is used, and the joints run solid.

I have made a great many joints on our low-service system with tarred rope and cement. These joints were made in the following manner: First, a coil of tarred rope is driven into the joint, then common hydraulic cement filled in, and another coil of tarred rope driven in.

These joints have been in use from twenty to twenty-five years; we have never had one leak, or give us any trouble.

Mr. Winslow. — We have some pipe in our place which was laid by contract, and the one who laid the pipe furnished the lead, and I suppose he wanted to get all the money he could out of it. The great trouble with that pipe has been owing to the shallow depth of the lead, and I have had all my trouble from leaks on that pipe. I have found some cases where the lead has not been more than half an inch in depth, and a man who worked for this contractor told me it was a rule given by him never to use over an inch in depth of lead. As far as the theoretical depth is concerned, I don't know but what it may be all right; but so far as the practical result is concerned, I always put in as little gasket as I can to keep the lead from passing through, and fill the rest with lead.

The President. — How deep is your joint?

Mr. Winslow. — Three inches. I calculate to get in all of two inches of lead, and I don't know that I have ever had a leak on any of such joints. Several years ago the Cambridge department was putting a 30-inch pipe through our place, and of course I was looking after points; and I noticed one thing they did was, when they had to swing their pipe and would make one side of the bell a little shallow, they would put in clay on the inside of the pipe and not use any gasket at all, and fill the joint solid. Well, in laying our 24-inch main from the reservoir I had occasion to do the same thing. I don't know whether the Cambridge folks have patented this idea or not. When I went around a bend in that shape, the depth of lead outside of the bead on the end of the pipe was not enough to suit me, and in consequence I would put clay on the inside of the pipe and leave it in such a way that the lead would pass the bead and make a clinch behind, and put in all the lead I could. I don't know whether that is an improvement on the way our Cambridge friends did it or not; and then the spare

space in the joint which was not filled with lead, between the bottom of the bell and the end of the spigot, I would fill in with Portland cement; so I think I have got a pretty solid job. I have had no leaks on it as yet. I have always gone on the idea that a pound or two pounds, or three or four pounds, of lead in a joint was a great deal cheaper than to get it down to the smallest possible quantity, and in the course of time have to dig it up and re-caulk it.

Mr. NEVONS. — I can't see, if the pipe is not being deflected from a true line, what good it does to put in lead beyond the curve after filling the curve. It seems to me that is a good rule to go by. In caulking up a joint I don't think you upset the lead more than a quarter of an inch in. Almost any joint you pour, if you let the water on without caulking it, the water will come out nearly all around it; but give it a few light taps with the hammer and you stop it. There has been lots of discussion on this topic, and it seems to me it is a matter of judgment when you are laying your pipe. We deflected that large main all it was possible to deflect it and run the joints, and we did as the gentleman has said, and we haven't had a single joint leak on the whole line since it was in operation.

Mr. ALLIS. — I notice Mr. Hancock stated in his paper that in some cases where he had low pressure he made a joint with cement and yarn, and I remember that Mr. Keating, of Halifax, at one of our meetings, said he had a system of caulking his joints with wooden plugs, cut out of the right size, which he drove in tight, and he said they were just as good as lead. I would like to ask Mr. Nevons what pressure they have in Halifax where they use these wooden plugs. And while I am about it, I would like to ask if anybody here uses yarn and cement for low pressures, or if anybody else uses wooden plugs.

Mr. NEVONS. — My recollection of the pressure at Halifax is that it is about 45 pounds on the leading mains of the city.

The PRESIDENT. — Is there any other subject you wish to discuss, or do you wish to continue the discussion of this subject any further?

Mr. FULLER. — In connection with this subject, perhaps the question of joint-room would come up naturally.

HOSE OUTLETS ON HYDRANTS.

Mr. WINSLOW. — I want to say a few words on a subject which is perhaps foreign to us, but perhaps it is not, and that is in regard to the standard size of hose outlets on hydrants. I got into a little difficulty not a great while ago, which I am not going to tell about (laughter), but it caused me to make inquiries, and I found that there are over 200 different sizes in the country. Around Boston there is supposed to be a standard, but I had quite a little trouble to find out what that standard was. It seems to me that is a thing which should be taken into consideration by the superintendents in ordering their hydrants, to know what the standard is for their place. I supposed I knew what ours was. The hydrants we had put in there first had a hose outlet and a steamer outlet. The hose outlet had a thread $3\frac{1}{16}$ inches to the outer edge, the biggest diameter. I had some other hydrants there, the Chapman hydrants, which we have been using now for eight or nine years, and they have always made them to a standard that was sent them with the first order, I take it. I found a few days ago that those outlets were three inches on the outside of the

thread, making a sixteenth of an inch difference. In getting some hose on to make a test I found that the coupling was very loose, indeed, and it had a very slight grip on the outlet, and one of the men who was with me was afraid it would pull off. It held all right, however. I found out afterwards that that hose was ordered from a new party, and the coupling sent to them for the sample. When we came to look at it, in sending samples to have hose outlets made by, we were laboring under a wrong idea, because, we will say, we have eight or ten different trials of that. The first man makes in his, perhaps, a hundredth of an inch variation, makes it a hundredth of an inch larger; and in course of time we send his to another man, and he makes his a hundredth of an inch different, and so on; and in the course of eight or ten we have got eight or ten hundredths of an inch out of the standard size; and the consequence is the first hose won't go on, and the last hose, perhaps, will be too large for the first hydrants. Having had this little difficulty, I thought it would be a good idea to speak of it so you could look the matter up before you ordered, and be sure to have something to go by, and not get caught.

Mr. FULLER. — I think that this is a matter which might well receive the attention of this Association. I have no doubt all hydrant men would be only too glad to come down to some uniform basis. I know that in ordering hydrants for different places we have to take this into consideration, and adopt the thread which is the nearest to that in use in the neighboring town; and if we make an extension, and order hydrants of another make, it often makes a great deal of trouble. And, as Mr. Brackett has said, some hydrants open to the left and some to the right, although I think the majority open to the right. It seems to me it would be a very good work for this Association to do something in the way of getting rid of some of these differences. Of course there are a great many cities and towns which have water works, and there are going to be a good many more, and if there is ever to be a reform made, it seems to me the sooner it is begun the better. I don't know how the other members feel about it, but I for one should be very glad to see something done by this Association looking towards a uniformity in the direction in which hydrants open, and also the size of the branches for both the hose and the steamer nozzles.

Mr. WALKER. — Before we adjourn, I think we should pass a vote of thanks to our retiring President for the manner in which he has served us. I am sure we all feel very grateful to him for what he has done, and it gives me great pleasure to move that the thanks of the Association be tendered to him for his very valuable and efficient service. Adopted.

The PRESIDENT. — I can only say the President has simply done his duty, and he desires to again thank the members of the Association for the honor which has been conferred upon him, and for what they have done during the past year. I hope we may all meet at Hartford next summer, and enjoy there, with many more of the members, the good time which all who attend our next convention will undoubtedly have.

Mr. NEVONS. — I move a vote of thanks now to our worthy Secretary, who always does well, but has done even better this year than ever before. (Applause.) Adopted.

Mr. COGGESHALL. — I don't know that I am expected to make a speech, but certainly this is a little beyond the mark. I thank you very much. I thank

you collectively, as I have many of you individually, for the kindness you have shown me during the past year, and I hope that things may go on this year so that when we meet at Hartford it will be for a rousing convention.

Mr. RINGROSE. — As the next convention has been mentioned both by the President and Secretary, it may not be out of place for me to say to the members of the Association that they have made no mistake in choosing Hartford for their place of meeting. It is right close by me, only about nine miles from my home; and I visit there often, and I know how well they can entertain. If there is anybody here in doubt on that point, I refer him to the Montgomery Guards, who are guests of the city of Portland at the present time. I think all the members who come there will never regret it.

Mr. WHITLOCK. — I would like to endorse most heartily Mr. Ringrose's remarks. I have had some experience with Hartford people, having lived there for three or four years, and I can assure the members of the Association they will have a very warm reception.

The PRESIDENT. — I am reminded of one thing I had almost forgotten. You all know we received a very cordial invitation to visit the city of Toronto, and Mr. Hamilton is very sorry that, owing to a provision of our constitution, we were not able to accept the invitation. He wishes me to say to all of the members of the Association that he should be most happy to have them call upon him at any time, individually or collectively, and to show them his works. (Applause.) Another point, and that is with regard to the invitation which was extended by the Portland Stone-Ware Company to visit their works. A number of gentlemen have said they would like to go, and it has been suggested that a good time would be after the return from the excursion to Lake Sebago tomorrow.

Mr. STEBEN. — I am very sorry, Mr. President, that according to your constitution you cannot once in awhile hold one of your conventions in Canada, and I regret especially that you were not able to accept the invitation of the Mayor of Toronto. I hope next year you will see the clause in the constitution is altered, and that we can have you with us in 1892. We would like it very much, and will do all we can to entertain you. And if before the constitution is changed any of you can make us a visit personally, we would be most happy to see you. (Applause.)

On motion of Mr. Nevons, the convention adjourned.

ATTENDANCE AT THE N. E. W. W. CONVENTION, HELD AT PORTLAND, JUNE, 1890.

ACTIVE MEMBERS.

Andrew, Frank A., Assistant Superintendent, Nashua, N.H.
Allis, Solon M., Superintendent, Malden, Mass.
Batchelder, Geo. E., Registrar, Worcester, Mass.
Baldwin, Chas. H., Boston, Mass.
Bancroft, Lewis M., Water Commissioner, Reading, Mass.
Barrett, Albert P., Registrar, Woburn, Mass.
Bayles, James C., President Spiral Weld Tube Co., East Orange, N.J.
Billings, Wm. R., Manufacturer, Taunton, Mass.

Brackett, Dexter, Superintendent Eastern Division, Boston, Mass.
Burnie, James, Superintendent, Biddeford, Me.
Cate, Edw. W., President Water Board, Newton, Mass.
Chace, Geo. F., Superintendent, Taunton, Mass.
Clark, Jonas M., Superintendent, Northampton, Mass.
Coggeshall, R. C. P., Superintendent, New Bedford, Mass.
Crandall, F. H., Superintendent, Burlington, Vt.
Crilly, P. F., Superintendent, Woburn, Mass.
Dean, F. W., Mechanical Engineer, Boston, Mass.
Dennett, Nathaniel, Superintendent, Somerville, Mass.
Dyer, Chas. R., Superintendent Meter Department, Portland, Me.
Dyer, Eben R., Superintendent Distribution, Portland, Me.
Eaton, Horace L., City Engineer, Somerville, Mass.
FitzGerald, Desmond, Superintendent Western Division, Brookline, Mass.
Fteley, Alphonse, Civil Engineer, New York City.
Fuller, F. L., Constructing Engineer, Boston, Mass.
Glover, Albert S., 113 Devonshire St., Boston, Mass.
Gould, J. A., Jr., Boston Water Works, Boston, Mass.
Gow, Robert M., Superintendent, Medford, Mass.
Gowing, E. H., Engineer, Boston, Mass.
Hamilton, Wm., Superintendent, Toronto, Ont.
Hastings, L. M., City Engineer, Cambridge, Mass.
Hawes, Wm. M., Water Commissioner, Fall River, Mass.
Hering, Rudolph, Civil Engineer, New York City.
Holden, H. G., Superintendent, Nashua, N.H.
Hyde, H. N., Jr., Superintendent, Newton, Mass.
Kieran, Patrick, Superintendent, Fall River, Mass.
Learned, W. F., Assistant Engineer, Boston, Mass.
Lockwood, Jos. A., Superintendent, Yonkers, N.Y.
Lowe, H. H., Superintendent, Clinton, Mass.
Lusk, Jas. L., Engineer, District Commissioner, Washington, D.C.
Martin, A. E., Superintendent, South Framingham, Mass.
McAllister, W. E., Superintendent, Calais, Me.
Morse, C. W., Superintendent, Haverhill, Mass.
Murphy, Jas. F., Water Commissioner, Marlboro', Mass.
Nevons, Hiram, Superintendent, Cambridge, Mass.
Osborne, Weaver, Water Commissioner, Fall River, Mass.
Parker, F. H., Water Commissioner, Burlington, Vt.
Pease, A. G., Water Commissioner, Spencer, Mass.
Philbin, John F., Registrar, Clinton, Mass.
Phipps, Edw. H., Superintendent, New Haven, Conn.
Ries, Geo. J., Superintendent, Weymouth, Mass.
Richards, W. H., Superintendent, New London, Conn.
Ringrose, J. W., Chairman Water Board, New Britain, Conn.
Roullier, G. A., Superintendent, Flushing, N.Y.
Salisbury, A. H., Superintendent, Lawrence, Mass.
Salmon, A. F., Water Commissioner, Lowell, Mass.
Sedgwick, Wm. T., Mass. Institute of Technology, Boston, Mass.

Stacy, Geo. A., Superintendent, Marlboro', Mass.
Stearns, Fred. P., Engineer State Board of Health, Boston, Mass.
Steben, B. F., Manager, Brockville, Ont.
Sullivan, Eugene S., Superintendent Mystic Division, Boston, Mass.
Volk, Fred A., Superintendent, Ware, Mass.
Wadleigh, Levi C., President Aqueduct Co., Haverhill, Mass.
Wescott, Geo. P., Treasurer Water Co., Portland, Me.
Whitcomb, W. H., President Water Co., Norway, Me.
Whitlock, Frank W., Assistant City Engineer, Waterbury, Conn.
Whitney, John C., Water Registrar, West Newton, Mass.
Wilder, F. W., Treasurer Aqueduct Co., Woodstock, Vt.
Winslow, Geo. E., Superintendent, Waltham, Mass.
Wiswall, E. T., Water Commissioner, West Newton, Mass.
Woodruff, Timothy, Superintendent, Bridgeton, N.J.
Wright, Willard F., Superintendent, Lowell, Mass.

Total of 71 Active.

ASSOCIATE MEMBERS.

Abbott, E. L., Water Waste Prevention Co., New York City.
Blossom, Albert A., Whittier Machine Co., Boston, Mass.
Carr, Geo. H., Union Water Meter Co., Worcester, Mass.
Dibble, F. J., Standard Thermometer Co., Peabody, Mass.
Freeman, S. H., Jarvis B. Edson, New York City.
Garrett, Jesse, R. D. Wood & Co., Philadelphia, Penn.
Givring, W. M., Fairbanks, Brown, & Co., New York City.
Goddard, W. N., King & Stoddard, Boston, Mass.
Hobson, Chas. H., Superintendent H. R. Barker Manufacturing Co., Lowell, Mass.
Jones, Octavous, Rensselaer Manufacturing Co., Troy, N.Y.
Kelley, John C., National Meter Co., New York City.
Kelley, John C., Jr., National Meter Co., New York City.
Mather, Thomas, H. R. Barker Manufacturing Co., Lowell, Mass.
Mitsch, J. A., Wm. H. Gallison, Boston, Mass.
Moulton, W. H., Union Water Meter Co., Worcester, Mass.
Pattee, R., Holyoke Hyd. and Iron Co., Holyoke, Mass.
Polsey, B. Frank, Walworth Manufacturing Co., Boston, Mass.
Ranton, Wm. J., Superintendent P. M. Co. Line, Syracuse, N.Y.
Rice, Edw. H., Walworth Manufacturing Co., Boston, Mass.
Ross, Edw. L., Chapman Valve Manufacturing Co., Indian Orchard, Mass.
Ross, George, Troy, N.Y.
Smith & Anthony, Manufacturers, Boston, Mass.
Stearn, F. E., Secretary Peet Valve Co., Boston, Mass.
Terry, B. S., A. W. Harris Oil Co., Providence, R.I.
Tilden, Jas. A., Superintendent Hersey Meter Co., Boston, Mass.
Ward, W. H., Boston, Mass.
Williams, E. B., Fairbanks, Brown, & Co., Boston, Mass.
Winton, H. D., Engineer Hersey Meter Co., Wellesley Hills, Mass.

Wolfendale, Wm., Agent Plumbers' Supplies, Fall River, Mass.
Worthley, A. W., American Frost Meter Co., Boston, Mass.
Total, 30 Associate.

HONORARY MEMBERS.

Frost, Geo. H., "Engineering News," New York City.
Meyer, Henry C., Editor "Engineering and Building Record," New York City.
Shepperd, F. W., "Fire and Water," New York City.
Total, 3 Honorary.

GUESTS.

Austin, A. H., Illinois Malleable Iron Co., Chicago, Ill.
Barton, Chas. A., Water Commissioner, Waltham, Mass.
Bond, Harold L., Supplies, Boston, Mass.
Brackett, Mrs. Dexter, Boston, Mass.
Brennan, M. F., Commissioner, Lowell, Mass.
Coggeshall, Mrs. R. C. P., New Bedford, Mass.
Daggett, A. B., Boston, Mass.
Daggett, Mrs. A. B., Boston, Mass.
Dickinson, W. A., Lowell, Mass.
Fairbairn, C. N., Boston, Mass.
Frost, Mrs. Geo. H., New York City.
Gleason, Fred. B., Marlboro', Mass.
Glover, Mrs. Albert S., Boston, Mass.
Goodnough, X. H., State Board of Health, Boston, Mass.
Gray, Saml. M., Civil Engineer, Providence, R.I.
Mortimer, Robert D. L., Water Commissioner, Marlboro', Mass.
Nelson, Clarence H., Contractor and Builder, Lowell, Mass.
Nevons, Mrs. H. B., Cambridge, Mass.
Parker, Mrs. F. H., Burlington, Vt.
Rice, Mrs. E. H., Boston, Mass.
Ross, Mrs. E. L., Indian Orchard, Mass.
Rounds, Fred H., Boston, Mass.
Total, 22 Guests.
Total attendance, as registered, 126.

LIST OF EXHIBITS BY ASSOCIATE MEMBERS AT THE CONVENTION.

Water-Waste Prevention Co., New York City, Water Meters and Strainers.
Union Water Meter Co., Worcester, Mass., Water Meters and Pressure Regulator.
American Frost Meter Co., Boston, Mass., Water Meters.
Geo. Ross, of Ross Valve Co., Troy, N.Y., Valves and Organ Blower.
H. R. Barker Manufacturing Co., Lowell, Mass., Valves and Organ Blower.

C. R. Dyer, of Belknap Water Motor Co., Portland, Me., Water Motors, and combined Water Motor and Coffee Mill.
Chapman Valve Manufacturing Co., Boston, Mass., Valves and Hydrants.
Peet Valve Co., Boston, Mass., Valves and Water Gates.
E. B. Williams, of Fairbanks, Brown, & Co., Valves and Fittings (Boston, Mass.).
Whittier Machine Co., Boston, Mass., Water Gates.
W. H. Gallison, Boston, Mass., Pipe and Fittings.
Geo. E. Winslow, Waltham, Mass., Electric Indicator and Recorder.
Standard Thermometer Co., Peabody, Mass., Electric Indicator and Recorder.
Smith & Anthony, Boston, Mass., Attachment for tapping Cement Pipe.
Porter Manufacturing Co., Syracuse, N.Y., Model of Standpipe.
Perrin, Seamans, & Co., Boston, Mass., Contractors' Supplies.
W. R. Billings, of Taunton Locomotive Manufacturing Co., Furnace and Stop Boxes.
Portland Stone-Ware Co., Portland, Me., Drain and Sewer Pipe.
Hersey Meter Co., So. Boston, Mass., Water Meters and Water Works Appliances.

LIST OF BLUE-PRINTS DISTRIBUTED AT THE CONVENTION.

Dexter Brackett, Boston, Table of Discharge of Service Pipes, from Annual Report, Rochester, N.Y.
C. E. Chandler, Norwich, Conn., Diagram showing Water Works Receipts.
F. H. Crandall, Burlington, Vt., Knuckle Joint on Discharge Pipe.
F. L. Fuller, Boston, Stand-Pipe Connections, Marblehead Water Works.
Hersey Meter Co., Boston, Meter Testing, Bench.
Rudolph Herring, New York, Coal Car, Toronto Water Works.
H. Nevons and L. M. Hastings, Cambridge, Pipe crossing Broad Canal.
W. H. Richards, New London, Conn., Tower and Tank for High Service.
B. F. Steben, Brockville, Ont., Suction Pipe, Inlet Filter Box.
B. F. Steben, Brockville, Ont., Pipe-Flanging Machine.

UTILIZATION OF SURFACE WATER FOR DRINKING PURPOSES.[1]

BY

PROF. WM. T. SEDGWICK.

In thinking over what might possibly be of interest to the Association, my eye fell upon a very important paper by one of the leading sanitary engineers of Europe, Mr. W. H. Lindley, of Frankfort. This paper is a summary of certain reports and results presented at the Paris Exposition to those interested in water-supplies, and might be called a paper upon the utilization of river-waters, or still more generally, perhaps, of surface water for drinking purposes. It is an old subject, of course; but old faces become new occasionally, and this appears to be one of the times when there have been marked changes in public opinion and in the opinion of competent engineers. The standards applied to drinking-water to-day are quite different from those which were applied a few years ago, and it is therefore very interesting to have a man like Lindley take up the whole subject of utilization of surface waters for drinking purposes, and give us the fruits of his full and ripe experience. I might say to those of you who happen not to know about him, that Mr. Lindley is an Englishman resident in Frankfort, and one who has constructed many important systems of water-supply in Europe.

The point of view from which he begins his paper is that we want, of course, the purest water we can get; that the purest water is spring water; that we cannot ordinarily use spring water, however, for large cities, because there is not enough of it. And one of the first conclusions he draws is, that as things are arranged at the present time it is more necessary that we should have a large quantity of water than high quality. That struck me when I first read it as a rather revolutionary idea, and as not being likely to chime in with the best results of modern hygiene. But after all, from a broad and general point of view, there is no doubt, I think, that it is so; that the first requisite of modern civilization in cities is an *abundant* supply of water, always supposing, of course, it is of fair quality; and that the next is its purity. Although, as I say, I was at first inclined to contest this and not agree with it at all, the nature of my pursuits leading me to take the other point of view, when I thought of the condition of Europe, for instance, in mediæval times, when people drank from foul wells; of the conditions which might exist to-day in large towns and cities if people were dependent upon wells, and had either to go without water or to take such water as they could get from the ground immediately about them, — I saw that there was a point there, and that it is, no doubt, taking it in a broad and general way, of the first importance to furnish communities with large supplies of water of a fair quality, in order to prevent them from using water which is very much worse in a limited quantity. One of the first things to look out for, then, in modern civilized life, where people are crowded together in masses, where cess-pools and sink drains and incidental contaminations pollute the soil, is a good supply in volume.

But unquestionably hard after that, if not even ahead of it, comes the purity

[1] This address was made without notes, and is printed substantially as given.

of the supply; and Lindley goes on to point out, as we all know, that it is usually impracticable to get enough from wells or cisterns, or even from filter basins alongside of rivers, for large cities. He lays great stress, however, and I think very justly, upon the great value of what we call in this neighborhood, or at least in Massachusetts, filter basins, — wells dug alongside of rivers; wells which were formerly supposed to drain from the river, and were therefore called filter basins, but which all engineers now know are really wells located alongside the river and receiving the water from the hills above, intercepting, as it were, the water on its way to the river. There is no sort of question that where we can get that kind of water, — and often we can get it in great abundance, — it is the ideal supply for a modern city. But it must be of sufficient quantity, and that cuts off a good many of our larger cities from its use. There is of course one grave danger, and that is the growth in such waters of *Crenothrix*. This plant, which has produced so much trouble in certain waters abroad, threatens to do damage in New England, and has in fact already ruined, or is ruining as fast as it can, the water-supplies of certain towns in Massachusetts, where the water as it flows from the ordinary tap is of a reddish-brown color, and contains long filaments of *Crenothrix*.

Passing on from such supplies, Lindley takes up the question of the utilization of rivers. Before that, however, he mentions the great desirability of legal protection of the mountain lakes, and says that even in Europe, where, of course, they have been working at it longer, they are very careless still about preserving the purity of the mountain-lake supplies. If one exists in the neighborhood of a growing city, it should be the duty of the city or of the State to enact proper laws for its protection while this is possible. It seems to me that there is a hint for water-works men. If we, for instance, are living in a growing city, and in the mountains not far away there is a perfectly pure lake, which, however, is about to be utilized for manufacturing purposes, or for a summer resort, or for anything of that sort, and so to be contaminated; then it becomes our duty as guardians of the public health to see to it that that is reserved in time, so that in the future it may be available for that which is one of the greatest blessings which mankind can possess, a pure water-supply.

However, most cities and large towns must apparently come sooner or later to the use of river-water. Now, river-water may be good or it may be bad. In case it is good, we should return thanks to a kind Providence. In case it is bad, what is to be done? That is a question which is pressing hard upon many European cities, and is bound to press upon us very soon. The tendency of people to gather together in cities is, as you know, almost a disease in modern times. One authority has called it the *morbus urbicus*, or city disease. Almost everybody wants to live in the city. And as people come to live in the cities they create for themselves new conditions, and conditions which must be overcome by new methods of hygiene. One of the most important of these is pure drinking-water. Not every city has a Lake Sebago to draw from. It must go to the river, oftentimes, and, unfortunately, the river may be seriously polluted, either by manufacturing establishments or by cities pouring their drainage into it. It is a sorry spectacle to go along the beautiful Hudson, which, to be sure, is used only in the upper part for drinking purposes, and see every town and city on the shore pouring its sewage into it; doing its best, without in-

tending it, of course, but really doing its best, to convert this noble river into an enormous sewer. It is only a just compensation, it seems to me, that the people of New York, who so largely contribute to this end, should be obliged to take their ice from the river, and that the ice is often as bad as the water is. I may say in passing that the ice taken from the Hudson river is shown to be so bad that the ice taken from Massachusetts lakes and rivers has been found, curiously enough, even the worst of it, to be better than the best — so I think I may safely say — of Hudson-river ice. This shows the amount of pollution that is there, and I say it is a national disgrace that this noble stream, the splendid Hudson, should be turned into an open sewer. I believe the time will come when the people of America will find some better means of getting rid of their sewage than turning it into the nearest stream.

But suppose they continue to do this and that we have to drink of it, what then? So far as I know, only one thing has been suggested, or two things, and those two things are sedimentation and filtration. In some of the European cities a good deal of dependence is placed on sedimentation, and in others a combination of sedimentation and filtration is employed; while in our own country we are seeking to learn the conditions of successful filtration, whether it be combined with previous sedimentation or not. The difficulty of protecting the purity of a watershed is so great that it is becoming practically impossible to deal with the water-supply problem in that way alone. In Lindley's paper are given very interesting detailed descriptions of filters which he has used and which others have used. The gist of it all is this: It is possible by means of carefully regulated, — and that is one of the most important points, — by means of carefully regulated sand filtration, to take out a large portion of the color from a brown water; it is possible to remove a considerable amount of the organic material; and what appears to be from the hygienist's point of view of still greater importance, it is possible by sand filtration to materially reduce the number of living germs which our rivers are oftentimes stocked with. It is possible, for instance, at Warsaw, in Russia, where there is one of Lindley's plants, to reduce the water from the Vistula from an average of seven or eight thousand bacteria to the cubic centimeter to ten or twenty, and to do it at a comparatively rapid rate. Whether it would be rapid enough for our American cities or not I cannot say, but it seems to me that those are just the problems we must look into. At any rate, the arrangement of the plants and their running is in theory comparatively simple. It is this: to build up a sandbank which shall be made of coarser pebbles and stones at the bottom, ordinarily beginning with those of the size of the fist or a little smaller, and gradually coming up to very fine sand on top; the approach to the filter area being so constructed as to turn the river-water through it. Of course this filter takes out the eels and the bigger things, but it takes out also a very large number of very little things. Almost immediately there is formed upon the top of the fine sand a sort of deposit, which has been found to be composed of the peculiar jelly-like condition of these very bacteria which we want to get rid of. The old idea of filtration was, that if you could have the sand clean and pure you would have the best possible filter. But that is not so at all. It is the formation of this gelatinous membrane over the top of the sand that makes the filter effective. The Pasteur filter, as you may perhaps know, the very expensive pipe-clay

filter, is the only known house filter which will remove all germs, and this is said not to do it invariably. It appears that artificial filters made of sand, and worked continuously, imitate by their membranous condition the finely porous condition of the so-called Pasteur filter.

Thus it appears that our ideas regarding filtration have greatly changed. When the Germans began their experiments, they took pains to have the sand as clean as it could be, and the result was that all the bacteria went through it. It takes a little time to accumulate this deposit or membrane, which must be just right, or very soon the filter will clog; and when the accumulation has gone too far, the filter must be cleaned. Men go along with wheelbarrows and clean off the top of the filter as often as is necessary, which is found to be about once in four weeks. The life of one of these sand-filters appears to be then on the average — at Warsaw, at any rate — about four weeks. After that it must be cleaned. It is at rest, of course, during the cleaning, and must be at rest for some little time after the cleaning; for immediately after cleaning it is not as effective as it should be. One of the great questions is, in northern climates, how to avoid the ice which accumulates on the filters. In Berlin, some of the filters are covered with a roof and some are not, and it is difficult to run those that are not covered, in winter, as the ice accumulates. In Warsaw, in Russia, this plant of which I have spoken has a roof over the filters, and they are run summer and winter. One of the pressing questions which arises in all these cases is whether it is better to run the filters continuously and then stop and clean them, letting them rest for awhile, or better to run them intermittently, thus letting them clean themselves. We all know what continuous and what intermittent filters are, and just at present one of the most interesting problems, it seems to me, which sanitary engineers have to solve is the determination of the relative life and capacity of intermittent and continuous filters for drinking-water. I am happy to say that my friend Mr. FitzGerald has started precisely such work at the Chestnut Hill reservoir, in Boston, and hopes to work out the problem in the next year or two. He has an interesting and valuable plant there, by which he is actually going ahead to test this question. The problem is simply this: Is it in the long run better and cheaper to run continuously or to run intermittently? By intermittent filtration natural processes come in, which effect the destruction of the accumulated organic matter, and therefore we never have to clean the filter, if it is properly managed. On the other hand, the filters have to be intermittently run, and that would seem to restrict the volume of water which can be filtered.

Of course, this applies also to other kinds of waters; and I am inclined to think that it would be well for any water-works superintendent who is dealing with a brown water, and who finds his people objecting to it, to filter that water, because he would take out so large a proportion of the color that the people would accept it thankfully, even if it did still contain things perceptible to the chemist. Filtration removes the larger organisms, the algæ and microscopical organisms of all kinds. The only things that go through are the germs or bacteria.

And just here comes in a very interesting and a very important experience which the city of Berlin has had this last year. In February, 1889, an epidemic of typhoid fever broke out in the city of Berlin, and, after locating it and studying it, the officials found that it was confined for the most part to one side of

the city. They looked into it more closely, and found that it was confined particularly to the district supplied by one of their water works. It was not common to all, nor widely distributed, but confined to the district which takes water from the river running through the city of Berlin, filtered through sand-filters such as I have been describing, worked on the continuous principle, and delivered to the people comparatively free from germs. Nevertheless, there came an epidemic of typhoid fever which had broken out upon this particular water-supply. You may or may not know that there has long been a debate in Germany and elsewhere over two different theories as to the cause of typhoid fever. There have been those who have held that it is the rise and fall of the ground-water which produces typhoid fever somehow or other, they do not know exactly how; and then there have been advocates, not of the ground-water theory, but of the drinking-water theory, who have claimed that it comes in the drinking-water quite apart from changes in the ground-water. There are certain cases, however, like the one in Caterham, England, where there is, apparently, not the slightest question that it came in the drinking-water. Of course, after the Berlin epidemic the adherents of the two theories fought, each claiming that it could not be explained on the theory of the other. Koch, the great bacteriologist, set himself to work to solve, if possible, this practical problem. Here were the continuous sand-filters of Berlin taking the polluted river-water, and fitting it so that it is to the eye wholesome and good, and to the microscopists and the bacteriologists as good as could be expected, considering its source. The question came up, could any of the germs of typhoid fever, supposing them to be in the river, have gotten through this continuous sand-filter? Some of the best scientific men in Germany went to work upon the subject, and found, contrary to the prevailing opinion, which was largely founded upon certain experiments made at Zurich, where they take the water of the lake and filter it through sand in the same way, that the germs of typhoid fever could go through these continuous sand-filters in large numbers, providing they were abundant enough in the river-water. That, of course, did not prove that the epidemic in Berlin came from the river-water, but it certainly gave high probability of it, and it did throw a good deal of interesting light on the passage of germs through continuous sand-filters. I may add that these experiments simply confirmed the results which have been obtained at the Lawrence Experiment Station of the Massachusetts State Board of Health, where it has been found, and proven beyond doubt, that certain germs may pass easily through certain of our sand-filters, in this case worked intermittently.

So we have to face these problems in purifying river-waters. We must do it rapidly; we have apparently to do it by means of sand filtration of some sort. But we must face the fact that if we take a polluted river and filter the water, either continuously or intermittently, through sand, unless we use just the right kind of sand, and do it in just the right way, we shall always run the risk, though it will be probably a small risk, — we shall always run the risk of getting some of the germs through the filters. Now, that, of course, is an unhappy conclusion. For while it is, therefore, possible to take a polluted river-water and purify it so that it shall be acceptable to the eye and not impugned by the public, it is not at present, with the information we have acquired, and in

the hands of ordinary managers, — it is not at present possible to do it upon a sufficiently large scale to meet the demands of a great city, and yet remove with the utmost and absolute certainty all of the germs of disease, if they are present in the river-water in great quantities. There, however, is the saving clause: if they are present in great quantities. We are sometimes frightened by reading figures of the germs of this, that, or the other in a river. There is a real danger there; but fortunately the danger is often exaggerated. If it were not, we must all have been dead long ago. In fact, disease germs are not often abundant in a river. They may be there, and may be there in very large numbers sometimes, but rarely; and it is possible to remove completely moderate quantities.

Bearing in mind the fact that the percentage of bacteria passing through these sand-filters is as small as it is, and bearing in mind the fact that the germs of disease, if there are any in the river, are very few, probably, except at very rare intervals it amounts practically, though not theoretically, to a very good protection and safeguard, if we can take the water even from a river receiving sewage and can pass it under proper conditions through sand-filters, either continuously or intermittently. And I think there is strong hope from some experiments which have been made at the Lawrence Experiment Station, — there is strong hope that by doing it just right, in the future, when we know a little more about it, we shall be able to protect ourselves absolutely against the germs of disease, if any, in the water of a river which is to be used for drinking purposes.

One word about the standards which hygienists and the best physicians are setting up for us now-a-days. It is important that medical men, sanitary engineers, and water-works men should work hand in hand; the first requisite of that is that they should understand each other; that the hygienists shall know the needs of the water-works men; that the sanitary engineer shall know the demands of the highest and best hygiene; for only then, it seems to me, can we work together effectively. Now, the standard at present set up is a very high one, — that set up by hygienists. It is that it is not right to give to any community water which may possibly contain disease germs. I say, "may possibly contain" them. That makes the standard high. And yet I suppose there are very few water-supplies in the country which would fill that bill as well as we could ask. That, however, is something to be striven toward; and, although there ought to be no unreasoning demand about it, and that which should be provided first and foremost is a requisite supply of fair quality in large volume, still I think it is well to have it understood distinctly and squarely that the highest demands of modern sanitary science will not be satisfied till the water supplied to a modern civilized community shall not only be free from objectionable appearances, such as dirty colors, and sticks, and water-fleas, but also shall be to the bacteriologist and the chemist beyond suspicion as containing no disease germs, or material for their support. I do not think it possible to maintain that standard to-day; but that, it seems to me, is something that we are working towards, and before very long are bound to reach.

Finally, I would say that if any of you are interested in this report of Mr. Lindley, which was made to one of the sections of the Paris Exposition, — regarding the utilization of river-waters, and as to the usage of filters, or the expense, — you will find it in a journal which I have in my hand, a German

quarterly devoted to the interests of the public health.[1] There you will find details as to the exact construction of the filters, and a picture of one of the filters in process of construction. I should like also to have it understood that I have said what I have said simply as matter of information. I believe, with the work which is now going on, and with the intelligence which is being gathered in conventions like this, we may eventually surpass other countries in the efficiency and intelligence with which our water works are to be constructed and administered. But at present I think we still have something to learn from others as well as for ourselves, and above all it seems to me that it ought to be distinctly understood that it is not right to use a polluted river as a source of water-supply, without putting it through some preliminary process of purification. Whether that is to be preceded by settling or not is a minor matter which will be for the engineer to determine at the time. But from the biological point of view, which is what I am personally interested in and desire to represent before you, I should like to say that I have this unfortunate fact to report, that there is every reason to believe that the germs of disease may go through continuous sand-filters as they are ordinarily run under the best conditions in foreign countries. We must therefore seek after a still more efficient way to protect ourselves from them absolutely. One additional fact, however, comes in: the moment the water has been filtered — not the moment, but as soon as possible after it has been filtered — it must be used. Because, having passed through the filter, having had all its conditions of life changed, being rid of a number of the things which were in it, it is now peopled with a limited number of bacteria. These find themselves in a free country, with nothing to compete with, and they may, therefore, multiply enormously. Filtered water, or at least that discharged from continuous filters, must be used as soon as possible after filtration. Such is the result of European experience.

The PRESIDENT. — This subject, which has been presented in such an interesting manner, is now open for discussion, and I will invite all here, whether members or guests, to take part in the discussion. I should be glad if there is any one here who has any acquaintance with the subject to have him give us the benefit of his information; or if any one has any question to ask of Professor Sedgwick, he will be glad to answer it.

Mr. ALLIS. — I would like to ask Professor Sedgwick whether it is probable that the article to which he has referred will be reprinted in any of the American journals. I have noticed that some of our scientific journals do reprint valuable articles of this kind.

Professor SEDGWICK. — I think Professor Drown, my colleague, intends to put the article into English, or at least to abstract it, and to print it. It strikes me that one of the functions of this Association should be the laying of foreign experience before its members in readable form, and I have no doubt that if the Association, through its officers or otherwise, were to ask Professor Drown to furnish this for publication in our JOURNAL, he would be very glad to do it.

The PRESIDENT. — I think that this can be left, perhaps, to the editors of the JOURNAL, and I have no doubt they will see that a portion or the whole of the paper is published for the benefit of the Association. Professor Sedgwick has in his

[1] *Deutsche Vierteljahrsschrift für öffentliche Gesundheitspflege*, Bd. xxii., 1890.

remarks referred to the work which Mr. FitzGerald is doing, and I know we should all like to hear from Mr. FitzGerald, either particularly concerning that or on the general subject.

Mr. FitzGerald. — Mr. President, I rise with a good deal of reluctance, sir, to say a word on this subject, after the admirable presentation that has been made of it by Professor Sedgwick. I think it is almost like looking at a beautiful picture, when one hardly likes to say a word, for it destroys the effect which you get from the picture itself. I certainly have never listened to a more admirable presentation of the theme. It is an epitome almost of the whole of water-works management from beginning to end, and I should suppose that Professor Sedgwick had been a practical manager of water works for many years.

These problems that he has stated so clearly are of growing importance. Of course we all know that a city must have quantity, and I think he began his remarks with the statement in substance that it was a question of quantity *versus* quality. Of course every town and city must have quantity, and practical men must always consider that as the thing of first importance, although, I regret to say, often with too little regard to the quality. I think that has been one of the troubles we have suffered from all over the country in the past. Building a storage reservoir or basin without much regard to its effect on the quality of the water, without removing the loam and properly preparing the ground, but just letting in the water regardless of the effects of the products of decomposition which may take place, may be a very cheap way to do, but I hardly think it is a fair thing to do for the health of the people. They may not apparently suffer from it as far as any visible signs are concerned, but I do not believe our senses were given to us for no purpose. I do not believe it is good for us to drink water that smells disagreeably. By the way, I may state here that I have had occasion a number of times to notice the effect of aerating large quantities of water containing sulphuretted hydrogen and other deleterious gases, and it is remarkable how water does purify itself by passing over a certain distance and in time. This applies to water that really contains products of decomposition, gases, and other things; but does not apply, however, to water that is pretty good at the start.

The subject of filtration is one which is just beginning, we may say, to engage the attention of men in a scientific way. The filters in England and on the continent have almost always been built after the same fashion; one man has started to do a thing and another man has copied after him, and that, I think, has been one of the troubles in connection with the practice of filtration. But our State Board of Health has shown us a new path. It has started out to investigate the thing from the modern scientific standpoint, and I have no doubt that the coming report which we shall soon have from it will be a model of its kind, and give us a great deal of valuable information. The experiments to which Professor Sedgwick so kindly referred, and which the President has asked me to describe, I hope, some time or other, after I have got further along, to say something about. I can only say now that my idea was to supplement the work of the State Board of Health, the admirable work that it has done, particularly with reference to sewage. I have six tanks at Chestnut Hill in which I hope to try different kinds of material, and to have continuous and intermittent filtration go on side by side, so I can get some definite results. We have been working on

it all winter, and it is now in operation. It is remarkable to see how our ideas change. I was brought up to believe a few years ago, from the authorities that I consulted, both those who have written books and those who have been practically connected with works, that filtration after all did not amount to very much, that it did not have much effect chemically, that it did not remove the deleterious germs, and all that; but I think our ideas are changing very rapidly on that subject. I am convinced that very poor filtration, or very imperfect filtration, has considerable chemical effect, and it has a good deal of mechanical effect.

I have had in mind since I have been on the floor here to say a word in regard to a practical way in which we can apply filtration cheaply, I think, and I have had occasion to look quite closely into the subject. There are a great many brooks, perhaps, or watercourses, that feed our basins, which are not what they should be. Now, it is a very easy thing to intercept those and carry the water on to the fields, — and I have had occasion to recommend that in several cases recently, — to carry the water on to areas, where they can be obtained cheaply, and simply let the water pass through natural filtration and find its way into the stream again. In that way the water is not lost, and it is very much purified. During the few days I have had my filters in operation I have been surprised to see how completely the color is removed, and I think even that alone is a very great advantage.

Mr. Bayles.— However perfect the filtration, it is simply mechanical. Professor Sedgwick has confirmed this by the authorities quoted by him; and the experience of experimenters goes to show it is almost, if not quite, impossible to devise any system of filtration which shall produce chemical purity in the water, unless the mechanical process is supplemented by the function of oxidation, and that to oxidation we must look for the ultimate elimination of the dangerous elements and ingredients in a water. Now, with that in view I have lately conducted some experiments which I think promise results of importance. After filtering the water and getting it as clean as I can from organic impurities, I cause it to enter — I will first describe the apparatus itself, briefly. It was originally built for a gas scraper. The gas entered at the bottom and forced its way up through a column of coke, which had no other function except to break it and diffuse it; while at the top entered a spray of water which washed the gas and allowed it to come out of the top reasonably clean and free from dust and impurities which were thus removed. I built a similar apparatus to this for the purification of water, filling the cylinder with coke for the same purpose, to break the column of air that was introduced, and diffused it, introducing water at the top and blowing in air at the bottom with a Sturtevant blower under a pressure of little over a pound. The water entering at the top of this vessel finds its way down against this ascending column of air with a very remarkable result in its effect upon the purity of the water. I have no proper facilities for making a delicate biological analysis; but with such facilities as I have, with the most careful test I could make, I have failed to find in the water emerging from that purifying process any trace of organic matter, and I believe it to be entirely destroyed by oxidation in the convenient form in which I get it. I will state I have taken care that this entering air should be as free from dust and impurity as possible, by introducing into the mouth of the tube through which I draw it — which, by the way, is raised at the mouth to bring it above the level of the

street — a fine screen of woven brass wire, which I have found very effective in keeping out floating particles in the air. I see no reason why it is not practical to apply this system on a considerable scale to the purification of impure water for town use. Air under a pressure of a pound or a pound and a half is easily obtained, and can be introduced directly into any portion of the system where there is a sufficient descent to overcome the pressure. Of course, if introduced into a level pipe it would blow the water out; but if there is a point in the system where a sufficient fall could be had to overcome this, the water thoroughly aerated in the way I have described would, I think, be put in the best condition, and we should have the benefit of the process of the most thorough oxidation which we can possibly get by any means now known to me.

Mr. NEVONS.— I would like to ask Professor Sedgwick if he places any particular value on aerating water.

Professor SEDGWICK. — That is a subject with which I have had but very little experience. The last speaker has apparently achieved good results in that way. I think there is no doubt, as Mr. FitzGerald said, that to run water over a broken surface does free it from gases, and does help it very much in some cases. With our present views on oxidation, however, it is impossible for me to see how even very pure air should carry the organic matter over to the nitrates, that is, the mineral condition. It has been conclusively established that in such waters, or at least in many organic infusions, oxidation takes place only by the agency of the bacteria; and, moreover, the time allowed would seem to me to be here too short. It is a subject I am not familiar with, though I must say I am quite surprised at the efficiency of the process of aeration as it has been described. If it is indeed as thorough as is said, it is a very valuable thing. But my experience or knowledge, so far as it goes, has not led me to attach any particular value to aeration, except for the removal of bad gases, or something of that sort, where there is a bad taste in the water.

Mr. FITZGERALD. — Oxygen is, of course, one of the substances that the disease germs live upon, isn't it, Professor Sedgwick?

Professor SEDGWICK. — Yes.

Mr. FITZGERALD. — Now, do I understand Mr. Bayles to say that the process he has described will remove the disease germs by providing too much oxygen.

Mr. BAYLES. — My reply to that is to repeat what I said before. I have had no opportunity, no facility, for delicate biological analysis; but in the most careful tests for the purity of the water, testing for organic matter, I have failed to find in thoroughly aerated water any trace of it. If it be true, as Mr. FitzGerald has stated, and which, I believe, is agreed by all authorities, that water running over a surface of broken rocks is thereby rendered pure, I think we have in that the analogy of nature, at least, to show that there may be valuable results from producing a similar effect upon the water by a more simple and expeditious process. If it will please Professor Sedgwick and be of any service I will be very glad to send him two samples of the same water, one before aeration by the system described, and one after, and have the Association have the benefit of any data he may gather from the examination. I am not an expert in biological analysis, and I cannot say whether or not the disease germs are entirely eliminated, but I do know, as a matter of fact, that the water is immensely improved in quality, and I should not hesitate to drink of such water that before such treatment I should decidedly object to drink.

Mr. FitzGerald. — I do not want to be misunderstood as saying that I think any amount of passage over rocks or exposure to the air makes the water pure, because water must be very impure, must contain a great many very bad substances, in order to be helped in that way, by that process. My experience has been that if a water is decently good it is not improved materially by the process of passing over rocks; and all I intended to say was that if it contained large quantities of sulphuretted hydrogen and other gases, they were dissipated.

Mr. Learned. — I would like to ask Professor Sedgwick how large a tank is required for filtering a million gallons of water?

Professor Sedgwick. — I do not think that has yet been sufficiently worked out.

Mr. Learned. — How large a tank is required, then, for the purpose of filtering any given amount of water? Of course, the filters would have to be larger or smaller, as the case might be, according to the amount of water we wished to filter, and what is the standard?

Professor Sedgwick. — I do not think there is any standard; that is one of the things we have got to learn, it varies so much in different cases. But there are some tanks in Lawrence, one of which has been running for two years and yet has never been cleaned. It has received the Merrimac river water, that is, the Lawrence city supply, after it has been through the pipes, improved a little by sedimentation and one thing and another. This one tank has been running for two years, has never been cleaned, yet has been running at the rate of about 300,000 gallons per acre per day. Then we have other tanks which have been running very much faster, some at the rate of 3,000,000 per acre per day for a while. That is precisely one of the things Mr. FitzGerald, also, is trying to find out. Any general statement that can be made would, I think, be worthless, because the efficiency varies so much according to the filtering material, and the water which is filtered.

Mr. Learned. — I didn't know but there might be now some ascertained standard.

Professor Sedgwick. — No; it is all so new. It varies very much in different places, and one would have to get a long list of figures to get the average, and then that would not mean much for America. But I hope that five years from now we shall be able to say directly how many gallons can be put most successfully through an acre of a given sand per day.

Mr. Learned. — In corroboration of the statement which has been made here in regard to the oxidation of water, I wish to say a few words from personal experience. In travelling over the Mystic valley watershed, some twenty-seven square miles in area, and the waters of which are very much polluted, I have had occasion to notice the character of the water from the sources of the streams to their mouths. There is one brook in particular which is especially foul. I don't know whether there is any Stoneham man here or not, but the brook I refer to is in Stoneham and is within the Mystic watershed. Stoneham is some four hundred feet perhaps above the level of the sea, and is a manufacturing town, thickly populated, and the brook, called Sweetwater brook, — which is a misnomer, by the way, — is extremely foul. It is black with filth, and it is disgusting sometimes to the smell. On the higher levels, where the flow of the brook is comparatively slow, the color of the water is very black; but as it reaches the

decline and flows and tumbles over the rocks in the course of a mile before it reaches the Abajona river, that blackness and that apparent foulness is largely eliminated. That, I presume, is entirely due to aeration or oxidation, as the case may be. I have noticed it not only with reference to that brook, but with regard to other brooks; and it occurred to me, while some of the gentlemen were talking, whether or not that might be a clue, instead, perhaps, a sedimentation, before the water became filtered. I merely present that as a thought.

Mr. HAWES. — If the discussion is pretty nearly at an end on this subject, I want to say a few words to caution the members of the Association not to run into an extreme on this matter. Professor Sedgwick and Mr. FitzGerald, and all these scientific gentlemen, are looking all the time for something bad in water (laughter), and there is danger that they may carry their ideas too far. I don't want the members of this Association to get the impression that all water is impure, and that it is not safe for them to drink it at all. (Laughter.) My advice is to get it just as pure as you can, either by filtration, agitation, tumblerization, or in any other way you can, and then drink it. But if you are still afraid of it, don't put in too much of the brown color which you have been so anxious to extract from it (laughter), but only just enough to kill the bacteria. (Laughter.)

Mr. FITZGERALD. — What is the name of that process?

Mr. HAWES. — Whiskeyization. (Laughter.) Get the idea out of your heads that you are drinking malaria and typhoid fever and all those things, and if you have to put anything into the water, put in just enough to kill the bacteria, and be sure not to put in enough to kill the man who drinks it. (Laughter.)

NOTES MADE IN HOLLAND IN 1887.

BY

A. W. LOCKE, C.E.

In the spring of 1887 the writer visited Holland, walked over that portion of the country lying between Rotterdam and Amsterdam and around in that vicinity.

As is well known the country is small, only about one hundred and seventy five by one hundred and twenty-five miles in greatest extent.

The low or reclaimed lands lie mostly in the provinces of North Holland, South Holland, Zeeland, Utrecht, and Friesland, while the provinces of Limberg, North Brabant, Guilderland, Overijsel, and Drenthe, lying more in the interior, and comprising about half the kingdom, are mostly dry and sandy.

The two provinces of North and South Holland, to which the following sketch principally refers, form the most characteristic and interesting part of the country. Within their borders are situated the cities of Rotterdam, Hague, Leyden, Harlem, and Amsterdam, and the great Harlem Polder, the greatest engineering work of its class in the world. These two little provinces are together only about ninety miles long and fifty miles wide in the widest place. But their soil, nine-tenths of which has been reclaimed from the sea, the lake, and the morass, is the home of a race which has not only carried on a success-

ful contest with the elements under more unfavorable circumstances than any people ever grappled with, but they at the same time created among themselves an original school of art, — the only original school that ever existed in a northern country, — and also in a long and bitter war defeated and drove out of their country the armies of Spain, the then most powerful nation of Europe.

In this region water is the one great question, not with reference to how it shall be secured and brought to the inhabitants, but how it shall be prevented from flooding the land and drowning out the inhabitants. They are like sailors who desire to go on with their everyday business, but, whether they do anything else or not, have got to keep themselves above water.

The country is flat. There are no hills. Along the brick-paved highways and crossing each other on the farms are many ditches from four to six feet wide. These lead into small canals. When the land is below the level of the large canals, as is often the case, the windmill or the steam-pump is called into use to force the water up into the large canal leading to the sea or the river.

CANALS.

The canals answer a double purpose: they conduct away the surplus water, and also they afford to the inhabitants the best system of inland communication in the world.

All the heavy business of the country is done on the canals except what is done on the few miles of railroad which they have. They vary from 25 feet to 100 feet in width, and the North Sea canal, which is the widest one I saw, and principally intended for navigation, is from 180 to 300 feet in width, and from 22 to 26 feet in depth.

The cities of the Low Countries usually are surrounded by canals constructed originally for the threefold purpose of navigation, drainage, and protection from enemies. Branches of these extend through the centres of the principal streets and afford a convenient way of discharging goods, which when unloaded from the steamer or barge are then carried or wheeled across the street to the store-house.

The sides of the canals in the cities are usually paved with stone or timber, and have no railings or other protection to prevent falling into the water, which, fortunately, is not very deep.

Many drawbridges cross the canals. They are simple in construction, and generally are moved by two great beams suspended horizontally in the air on the principle of a New England well-sweep. When a barge approaches, the draw-tender pulls down on a rope, and the bridge rears up promptly and allows it to pass.

PUMPS.

Steam-power is used to a considerable extent in raising the water. There are very large steam pumping-engines at Katwijk, at Halfway, at Cruquers, which I saw, — the first at the outlet of the old Rhine near Leyden, and the two latter near Harlem, on the banks of the Harlem polder. And there are other similar engines in the vicinity.

The old Rhine is called a dead river. Once it had a natural outlet, but storms cast up the sands of the North Sea and choked it in the ninth century. In 1807 an

artificial outlet was opened at Katwijk, and now the waters are pumped in rainy seasons from the land into the old Rhine, which drags itself slowly to this outlet and is pumped into the sea.

There are four engines at this place, and they operate six great, horizontal paddle-wheels, which somewhat resemble the side-wheels of a steamer. Each wheel has twenty-four paddles; each paddle has a surface of 2½ by 2¼ metres. The diameter of the wheel, paddles and all, is about 9 metres. The whole of this machinery at Katwijk is capable of discharging 120,000 cubic metres of water per hour. These wheels are built on the same principle as an ancient wind-mill water-wheel, and push the water up an inclined plane to the required level, and a flood-gate prevents it from returning when the wheel stops.

Each paddle is placed at an angle of about forty-five degrees, with a tangent at the point where it is attached to the drum.

DYKES.

Many miles of dykes may be seen guarding the land and the inhabitants against floods from without. They seem to have been built wherever they were needed, regardless of expense.

On the west coast they are unnecessary, as the waves of the North Sea have cast up a long ridge of sand extending from Helder to the north of the Maas, about seventy-five miles. But all along the low shore of the Zuider Zee, on the banks of the net-work of rivers which form the outlet of the Rhine, and around the large polders, and each side of many of the canals when they are raised above the land, the dykes and dams may be seen silently doing their duty. Oftentimes they stand on dry land in the summer, and are only intended to hold back floods which occur in the wet seasons, as, for instance, the dykes each side of the Maas from Rotterdam to the sea. And, again, they are constantly on duty; and of this variety is the dyke or dam across the mouth of the Ij, near Schillingwout, to keep back out of the North Sea canal and out of the streets of Amsterdam the waters of the Zuider Zee. This dam is about ten feet above the water and fifteen feet wide on top. Its slopes are paved nearly to the top with blocks of stone showing a surface from a foot square up to three feet square. It is about a mile long, and has three locks for the passage of water and such vessels as can navigate the shallow waters of the Zuider Zee.

When I saw these locks, the water in the Zee was about two feet higher than in Amsterdam harbor. The marks on the dam and stone-work indicated that it had been about six feet higher outside the dam than inside in the harbor.

When the ground is soft, or when other foundations are impracticable, a great deal of willow-work is used. I noticed an example of this at Katwijk, the outlet of the old Rhine. There the shore seems to be entirely of sand. The artificial opening through this sand is protected both sides by interlaced willow-work, weighted with square blocks of stone. The willow-work showed about five feet above the water when I saw it.

It seemed to me that this method of protection would be inadequate to withstand waves such as we have on the Atlantic coast. But I judged that the sea heaving ashore was not very severe even in storms, as there were in sight about two hundred fishing-vessels near the shore, having no harbor within twenty

miles, and no place of refuge except the beach, where several were already grounded at low-water mark and discharging their cargoes.

The dykes and peculiar water system of Holland have not only been the source of Dutch prosperity, but have enabled them to overcome their enemies when all other means failed.

In 1574 the Spaniards besieged Leyden, and the Prince of Orange cut the dyke in sixty places, and let in the waters of the Maas and Issel. These waters, driven by the south wind, found their way to the gates of Leyden, eighteen miles distant. The Dutch, in boats floating on a level with the tops of abandoned houses and among the branches of the trees, dispersed the retreating Spaniards with great slaughter. Between Rotterdam and Delftshaven one of these places may be seen to-day where the dyke was cut and afterwards repaired.

WINDMILLS.

There is no fuel in Holland except peat, and of course no water-power, so the inhabitants have for centuries made use of the wind, which seemed to be almost the only force of nature which could be made useful to them.

The windmills are used for many different purposes, not only for pumping water from the land into the canals, but for grinding grain, sawing lumber, and for many other purposes, such as steam and water power are used for in other countries.

I examined one windmill in Leyden used for sawing lumber. It had sixty-one up-and-down saws in gangs; twenty-eight of them were running at the time, sawing spruce and oak. Logs from Norway and Georgia pine from the United States were pointed out to me floating in the canal. This mill cost $12,000. Those used for pumping alone cost $4,000. They push the water up an inclined plane of about four feet rise with a paddle-wheel, and they can raise from 5,000 to 10,000 gallons per minute. Each mill is in charge of a man who, with his family, makes it a home.

On the highway between Harlem and Amsterdam I was able to count fifty windmills in sight at a time, and in the town of Zaandam near by are said to be four hundred.

USES TO WHICH WATER IS PUT.

Water is very useful in Holland for navigation and for cleaning and scrubbing. For drinking and for domestic purposes its purity does not seem to be much depended upon. They mostly boil the water in the shape of coffee or tea before drinking it, and they seem to be convinced that beer, brandy, and particularly gin, are safeguards against malaria. They sell the gin from fountains as we do soda-water, and there are two hundred distilleries making it in the city of Schiedam alone.

The houses all look very clean and bright, and as if they had been just scrubbed. Every morning the house-floors are thoroughly scrubbed, and generally the door-steps, and sidewalk, and front fence, and also the front side of the house, and the wooden shoes, which latter may be seen laid out in the sun to dry. This work is done by the Dutch servant-maids, who are very numerous; and while they are doing such work they never fail to look fresh and clean as ever, with their lace caps and fresh complexions, and strong, robust figures.

Nearly every house has handsome pots of flowers inside of its clean windows, which have a very inviting look. They give an impression that there is something very nice inside.

The water in the canals is about the color of coffee, also the barges and yachts which navigate them.

The freight barges are generally loaded to the water's edge, and have one mast hinged and weighted so that it can be lowered to go under bridges. They have great lea-boards to assist in sailing on the wind, and elaborately curved and very wide rudders. When the wind is favorable they go on very comfortably, but when it is contrary (and it always blows some way) the man gets out the 300 feet of small tow-line, and tugs the boat along, while his wife steers, and rocks the baby, and cooks dinner, all at the same time. The captain's daughter washes the dishes by sousing them over the side, and when that is all done scours the shovel and tongs; while the younger children run up and down the deck, with no rail to keep them from falling overboard, and the week's washing, hanging on the end of the main boom, flutters in the wind.

The yachts which sail on the canals and rivers are the clumsiest in the world, shaped like half of an English walnut shell, and with great lea-boards and wide rudders they plough up the water into foam, and their owners seem to think they are going fast.

The model of a Dutch vessel has probably not changed materially in the last two hundred and fifty years. In old pictures of about that age you may see the same shapes as are in use to-day.

BUILDINGS.

The buildings are about all of brick. The brick are made in large quantities, and of the very best quality. The county roads and many of the city streets are paved with them.

Most of the buildings and structures of all kinds are on pile foundations, and the piles are in some cases giving out.

Whole rows of old, tall Dutch houses, built two hundred years ago, or more, may be seen leaning one way or the other. Generally they lean towards the street. A very old one may lean out two feet at the top. Then the next one, built a little later, will not lean out so much; and so they are in and out at the top, and flush at the bottom. Sometimes a length of a hundred feet or so will lean towards the street, and sometimes they will keel over sideways for two or three hundred feet, one following the other like a row of bricks on end.

Amsterdam has been called the Venice of the North. Both cities are built on piles, and both have many canals; but the resemblance stops there. Amsterdam is the home of industry; Venice lacks enterprise, and has no visible means of support. There is no enterprise, but much laziness. In Venice are no vehicles, and nothing that we would call streets; every one gets about either by gondola or on foot. But in Amsterdam the heavy-goods business only is done on the canals, while the people ride and walk in the streets.

Venice is Oriental and sumptuous, while Amsterdam, like other Dutch cities, though artistic, is of the North, plain and substantial.

AGRICULTURE.

The soil in the Low Country is very rich, being formed of the muddy bottoms of lakes and swamps. The farmers have the mild climate of Western Europe to help them, and are not troubled by drouth in the dryest seasons, as there is always plenty of water at hand to irrigate the land, if necessary. These favorable circumstances, with their industrious habits, have made them very prosperous, and in a great many cases wealthy. Their farm-houses and barns are the best I have ever seen. Their barns, especially, are models of neatness and order. Their cattle are all alike, being black and white, and very handsome, and in cool weather covered with a short blanket when turned out to pasture. To go on to a Dutchman's land without his consent is difficult. There are no fences, but in their places are ditches too wide to jump across, and with miry bottoms too deep to wade. The ditch runs straight along in front of the house, and you get in there by a bridge, and that bridge has a gate on it, locked with a lock, and the fence extends out into the air each side of the bridge so that you cannot get around it. You ring a bell by pulling a wire which runs from gate to house, and some one comes out and opens. On every one of these gates is a sign which says, "Verboden Togang," meaning *Forbidden to go*. Nothing is open or free except the road, and you have got to stay in it. They are all very jealous of the stranger, and keep him at a distance.

A great deal of the land is in the shape of polders. A polder is a reclaimed lake or morass, where pumping is necessary a part or all the year to keep the water down to a proper level. Sometimes a single windmill will keep a polder dry.

About five miles south-west of Amsterdam is a polder of seven hundred acres, which is kept in good condition by one windmill, said to have been running there over two hundred years.

The largest of the polders is the Harlem mermere. Previous to 1840 this was a lake about eighteen miles long; it is now all under cultivation, and is inhabited by 12,000 people. Its lowest point is sixteen feet seven inches below ordinary high water at Amsterdam. As I approached this polder the chimneys of the houses and the tops of the trees were barely visible above the banks of the canal which surround it. The great pumping-engines were at rest, as the evaporation was sufficient at that time to prevent the water from rising too high.

CONCLUSION.

The foregoing is but an inadequate account of what came to my notice in Holland. Everywhere are visible the great works of a brave, persevering, and artistic people. A water-soaked region of lakes and overflowing rivers, substantially without timber, fuel, water-power, or mineral wealth; a region where man has had to do everything for himself, with about all the elements against him, has been transferred into a densely populated, independent country, giving at least some foundation for the Dutch proverb that "God made the sea, but man made the land."

WHY I FAVOR THE USE OF CEMENT PIPE.

BY

P. F. CRILLY, Superintendent, Woburn, Mass.

During the many discussions that have arisen concerning the relative merits of cement and cast-iron pipe, which it seems is fast approaching "an irrepressible conflict," I have been often asked "Why I favor the use of cement pipe." This question I propose to answer as clearly and concisely as possible, within the limits of the brief paper I have the honor to offer at this time for your consideration, although it is difficult to present in written form the many reasons which I might bring forward "for the faith that is in me," as to the superiority of cement pipe over cast-iron. Another difficulty presents itself from the fact that, having but recently become a member of this Association, I am ignorant as to what has been said or done in reference to this subject at previous meetings, although I understand that it has been discussed and "cussed" *ad infinitum*. I may, therefore, find myself in the situation of a raw recruit when entering his first fight, who, not knowing what is before him, throws himself into the conflict with more courage than discretion, while the veteran, rendered cautious by experience, moves more quietly, though no less effectively, or — does not move at all.

The first *desideratum*, in any system of water works, is to secure to the consumer an uninterrupted supply of pure, wholesome water, free from all corrosion which will tend to obstruct its free passage or impair its quality. That this initial demand, at least, is fully met in the use of cement pipe for the conveyance of water is conceded by all practical men; for where they are opposed to its use as supply mains, it is heartily endorsed for purposes of service construction. What is thus considered the best pipe for one important branch of the works, it seems to me is equally available for the other; for whatever superiority it possesses in the one case is certainly not lost when utilized on a larger scale only, on the other. As, therefore, it has become necessary to employ cement pipe for services, how much more the necessity exists that nothing inferior in excellence should be used for the supply mains, without which all service pipe would be useless.

Durability and freedom from corrosion are the two essentials to be sought for in systems of water-pipes, and as practically there are but two such systems, the cement and cast-iron, the issue is easily made up between them. As these vital requirements are fully met in the use of one, and entirely wanting in the other, a decision is easily arrived at, and upon the merits of the case must be pronounced in favor of cement pipe.

Here I desire to be understood, in speaking of cement pipe, that I refer only to pipe that is *honestly* made and *properly* laid, and not to the so-called cement pipe, made or laid with sand, with just enough cement used to hold it together until it is buried out of sight, or to pipe, otherwise of good quality, which is rendered practically worthless from lack of proper care in laying. Undoubtedly much of the opposition to cement pipe, though by no means all, is due to the annoyance and expense in maintaining systems thus badly constructed,

and, therefore, when we come to inquire why the use of cast-iron pipe is still so strenuously insisted upon, the answer is readily at hand. No criticism can be too severe, when directed towards those who are responsible for this state of affairs, whereby the welfare of whole communities is imperilled, and the true merits of the pipe itself is completely lost sight of, through incompetency and lack of honest business methods.

It has been stated on good authority that the life of cast-iron pipe in connection with water works is limited to twenty years, or twenty-five at most, after which time, owing to corrosion which fills up the pipe, and reduces its capacity for duty to such an extent as to be virtually useless, or becomes so corrugated and rust-eaten as to be admirably adapted for a first-class sieve, it becomes absolutely necessary to replace the whole system with new pipe. That this work of renewal is constantly going on in cast-iron systems is too well known to require specifications, not from want of thorough workmanship and material in the first place, but resulting from a defect, inherent in all cast-iron pipe itself, which thus far all known processes of coating have failed to overcome. Whole lines of cast-iron mains may be renewed without exciting comment; but let it become necessary for any cause to take up cement pipe, however much or little, and at once it is heralded near and far as a proof of its inferiority to cast-iron, and the decree goes forth that no more cement pipe shall be used, and what is remaining must be replaced as soon as practicable with cast-iron. It never seems to occur to them that cement pipe might be replaced with cement pipe. Now, what do we find in the record in reference to cement pipe. We find not only that it has been in satisfactory use for from twenty to forty years, but that it shows every indication of many years of usefulness to come; we find that it is capable of rendering the same service as when first laid; we find, most important of all, that the water it distributes is as clean and free from rust or discoloration as when it leaves its source of supply.

Here, it seems, the question of the relative durability of the two systems is settled, and settled in favor of cement pipe; but there is another important consideration which must not be lost sight of. Water works cost money, and a great deal of it, and a due regard for the financial interests of the community demands that the very best methods attainable should be employed in its construction and management, and that whatever is done should be well done, not for the immediate present alone, but for the far future. In this view, it must certainly be allowed that cast-iron pipe fails to meet the demand. When we find that, perhaps even before the original debt incurred for water works is cancelled, it becomes necessary to incur another equally as large, in order to make good what has just been paid for, or, what amounts to the same thing, though less likely to attract the average attention, loans are necessarily made from time to time. As the work of renewal progresses, we are forced to the conclusion that "somebody blundered," and that however honest in intention, they erred in judgment in not adopting the best and most durable pipe system, the cement-lined.

Experience, however, is the best teacher, and my faith in cement pipe is grounded upon facts which have come under my own observation. With rare judgment and foresight the commissioners in charge of the original construction of our works, after a very careful and exhaustive investigation, recommended

the adoption of cement pipe. After a trial of seventeen years, the result of their decision shows to-day "that they builded better than they knew," as we find our entire system is improving year by year, while the necessary repairs are decreasing. During the past seven months, with forty-three miles of mains, we have made five repairs of all descriptions, two only of which were of any importance, due primarily to careless workmanship, being contract work; this, of course, does not reflect upon the merits of the pipe itself. In these two cases it was found that the pipe rested upon the rock itself, the trench being cut through a ledge, without any outside covering of cement; it is pertinent to inquire that if pipe in that condition, under such circumstances, will last seventeen years, how long would pipes properly laid remain unimpaired.

Having occasion, in 1886, to lay an additional 12-in. supply main from the pumping-station, some 3,000 feet of 4-in. and 6-in. pipe was taken up, and found in better condition than when first laid, while a 6-in. gate, on the line taken up, dipped in tar at that, was so badly corroded as to reduce the water-way to less than two inches. The pipe thus taken up was relaid in other localities, and we have had no trouble with it since that time. Samples of 4-in. and 12-in. pipe are now in our office, which, after a service of thirteen years, present on the inside a smooth, clean appearance, while the iron on the outside is as bright and free from corrosion as when new. As a further illustration of what would be the condition of our system in the future if laid with cast-iron pipe, I have with me a sample of 1¼-in. pipe which had been used for a service; no wonder the consumer complained of lack of water, as you will see it is completely filled with rust. I have also a sample of cast-iron elbow, with cement-pipe connection, which is ocular evidence of the comparative durability of the two pipes. Both of these samples have been in use about fifteen years. I also have samples of 4-in. and 6-in. cement pipe, which I have cut out recently for the purpose of making connections, which have been in use about seventeen years. I present these samples merely to illustrate the tensile strength of the cement, when subjected to the severe jar in cutting; and when upon examination it is seen that the proportion of sand to cement is nearly one-half instead of one-fourth, as it should be, they speak well, imperfect as they are, for cement pipes.

Many other and important reasons might be advanced in support of my position on this much-mooted question; but this already lengthy paper admonishes me to come to a close; doubtless some of them will be brought out during the discussion to follow. I thank you most heartily for the kind attention with which you have honored me in the presentation of this paper, and if I have been able to present any new thought worthy of your consideration, I am well repaid. In conclusion, I would earnestly hope that this important matter be considered on its merits alone, all bias or prejudice thrown aside, and that the discussion will be conducted in a manly, business-like manner, such as well might be expected from those upon whom such great responsibilities rest; as has been well said, the health, prosperity, and general welfare of communities depend largely upon the fidelity with which we perform our trust. It is a duty we owe not only to ourselves, but to those we represent, that on such occasions as these we should honestly endeavor to secure the best possible methods for carrying on our work.

The PRESIDENT. — We certainly have a subject now before us with which a good many of our members have had experience, and we should like to hear from some of them.

Mr. NEVONS. — I think Mr. Walker can say something on this subject. (Laughter and applause.)

Mr. WALKER. — I have nothing to say with regard to cement pipe, because I have been too much afflicted with it, and I might not use fairly the paper which has been read to us. There is a good deal in it, and I shouldn't like to get into a discussion about it. I have lately filled up the cellar of an engine-house with this kind of pipe, and you know what kind of fellows firemen are when you get them riled. Everything was afloat down there, and I had a good deal of trouble in straightening them out and getting them regulated. When I took charge of our water works fifteen years ago, I went down to Worcester, and I asked a friend — Hall — to show me why he liked cement pipe better than he did cast-iron pipe, and in what respects it was better. I said to him, "I have got it to take care of in Manchester, and now I want to know all about it." He said he didn't want me to ask him any questions, because his folks were in favor of cement pipe, but he would show me what he could about it, and I could see for myself. So he took me into a room about ten feet square, I guess it was, and he had there about twenty pieces of cement pipe, one of which had been laid seven years, and I think the others had been laid eight years, — none more than nine years, — and it was a pretty hard-looking sight. I looked at them, and I hadn't the courage to ask him any questions after that. But as I understand it, we have discussed this matter before, and we then came to the conclusion that the reason they used so much cement pipe in former times was because cast-iron was so expensive, but since it has got so cheap I don't think there is any excuse for it. But still some people will use it. (Laughter.) For instance, they laid it up in Keene, and they told me the trouble was that we didn't have the right man to lay it in Manchester, that they had got it in Keene under a 300-foot head, and not a leak in it. I said, "Wait a little while. I have to get up in the night and run around after mine to shut off the gates; I can't sleep half the time, and perhaps I am getting a little crazy on this subject (laughter); but if you have got anybody who can lay cement pipe in Keene, and lay it so it won't leak, I would like to see him." They said that Goodhue & Birnie laid it there, and there wasn't a leak, and 300-foot head. The next time I saw my Keene friend was about a year afterwards, and he then said they had had a few leaks in their joints, that was all, and there was nothing like it. Wash-day was a pleasure (laughter); no rust on the clothes, and a fellow's shirt-bosom would shine as if it had just come out of a Chinaman's shop. (Laughter.) Well, I will pass over a little time now, and about a year ago I saw this same person, and I said, "How is that cement pipe working up there at Keene now?" — "Oh, God, it is awful! (Laughter.) It fills up all the cellars and everything else, and we are shut off half the time." I have had to settle four or five cases in Manchester this last winter where we have filled up cellars. One rather bad one was the case of an apothecary shop, where they sold rum and stuff for medicine under a doctor's prescription, and that cost us about $300. And so it has been all along. It has been a continual expense to us. We have lately taken up some of our pipe. Some pieces of it are just as good as when it was laid, and

other pieces you can cut with your jack-knife. In some cases roots of trees get under the cement and hoist it right off. It is bursting all the time. (Laughter.)

When I was taking up this pipe one of these fellows who know what ought to be done — there are always a lot of fellows who can say what ought to have been done — would come along and say, "What in the devil did the commissioners put this pipe down for in the first place, Walker? I told them at the time it wasn't good for anything." The commissioners went around, and they found people who said that cement pipe was just the thing. They went to New Britain, Conn.; but I got a letter from New Britain, Conn., saying it isn't good for anything. They went all through the country and recommended some at half price, and saved $100,000 by laying cement pipe. And I have no doubt that the cement pipe can be laid in good hard ground so it will last for years, but you can't go on to a meadow with it but what it will crack and the water will get under the cement. There is no mistake about it but what to lay cement pipe and have it good for anything you have got to have every foot of it laid upon honor, and by the time you have laid it it has cost about as much as cast-iron. They say that it will last forever, and I have no doubt some pieces will; but the question comes with us, can we afford to lay it in the streets, and to run the risk of having it laid just right and of not cracking off a piece of the cement? There is too much risk in handling it. You can tumble cast-iron into the ditch and lay it, and if a joint leaks you haven't got to shut anybody's water off, because you can take a hammer and calk it up. There is no woman coming around on washing-day and saying she must have water or the old man must lug it. (Laughter.) I had supposed we had all decided in favor of cast-iron pipe, and I came down here yesterday to see a man who had the courage to get up before this body and advocate the use of cement pipe. I wanted to see him. (Laughter.) I have had so much trouble with it that I had the curiosity to see a man who could get along with it. There is not a week but we are having trouble with it. They say it is all owing to how you lay it, and I am glad to see a man who knows how to lay it and not have any trouble with it. It does me good to look at him, and I am glad he has got the courage to defend it.

Mr. DENNETT. — Cement pipe, as Mr. Walker says, may last a long time, but my experience has been such that I can't say much in favor of it. We have from six to eight bursts a week upon it, and I really can't say anything in favor of it.

Mr. WALKER. — The greatest trouble we all experience is a cement-pipe man who will come along with a piece that is nice,— I can find it in my own city,— and tells us what that has done, and then he will take a piece of cast-iron pipe that is filled with rust and show that. Then another man, who is in favor of cast-iron pipe, will come along with a piece of cement pipe that is all torn to bits, and he will compare that with his nice piece of cast-iron pipe which has been laid thirty years; probably it has been nicely brushed out, you know; and we have all that to contend against. I want to get the best thing to lay, myself. There are a good many people who don't want to drink through lead, and say it is bad stuff. But the soft waters won't affect the lead any that I can see, for we have had a piece of lead lying in Massabesic lake ever since the work started, and it as good now as when it was put in. We have tried all kinds of pipe, and it is pretty hard to get at this matter, and get at it right, and get the best thing; but I

am satisfied that what will work well for service pipe in one place won't work well in another.

Mr. ALLIS. — One of the reasons the writer of the paper gives why he thinks cement pipe is good for mains is because it works so well for services. I should like to know how many of this Association use cement-lined pipe for services. I think there are not many, but you would have supposed from what he said that it was universal. Now, with regard to service pipe, we have found we have been obliged to take out so much iron that we have decided to use lead entirely, and we don't use anything else now. If we are wrong, I should like to know it; but we think that lead pipe for services is about the cheapest thing we can get, and the handiest thing to put into the ground and make a good job of. As to cement pipe, you all know our experience in Malden, and so I won't go over that. The writer intimates that the life of cast-iron pipe is only twenty-five years. I am greatly surprised at that statement, and I would like to know what you gentlemen think about that. From all I have heard and read on this subject I have been led to believe that a good cast-iron pipe will last fifty years, and it has been known to last one hundred and one hundred and fifty years; and I don't see why cast-iron pipe properly made and laid won't last a hundred years. I don't see any reason why it should not, except in certain soils, where it is made land and very wet, and where all sorts of things will attack it, as we know it is the case in some sections; but these things have the same effect on cement pipe. I have found in my experience that if I have a cement pipe laid through very low, wet ground, that there is where I have most of the breaks. But if I have cement pipe laid in dry sand, or in a nice dry place upon a hill, it will last a good while; but it will finally break. I believe that when they have had this pipe in Woburn for twenty years or twenty-five years they will have the same trouble with it that they have in other places. For my part, it will need a good deal of argument to get me to favor cement pipe.

Mr. NEVONS. — It seems to me there is a little misunderstanding about this matter, and that it all depends on the thickness of the iron. I thought this convention had decided on the merits of the two kinds of pipe, and had come to the conclusion that cement-lined pipe was the best, if you only had your iron thick enough, and that it ought to be somewhere from three-quarters to seven-eighths of an inch thick, and then you can put all the cement in that you want to. (Laughter.)

Mr. STEBEN. — Our works have been in operation about nine years, and we have got about twelve miles of iron pipe through the city. Of course, whenever we have to make new connections to put in hydrants, we have to cut off the pipe, and we have done that within the last two months, and have found the pipe as clean as it was when it was put down. We find that the pipe is first-class in every way. Last summer we only had four leaks, and those were not owing to defective pipe, but to defective joints. Sometimes the back pressure would work the joints in some way, and that would cause a leak after a while. I saw a sample of pipe here a little while ago called a service pipe of wrought-iron. I think it is somewhat unfair to present such a sample to the Association, because really I think any man who would put such a pipe as that in for a service pipe must have lots of money to throw away. In our place we never think of using such pipe as that. Our service pipe is half-inch, five-eighths, and three-quarters

lead, and anything over three-quarter inch is galvanized iron. About a year after we started to pump we put in some iron pipe, two services, to see how long it would last. We found the common wrought-iron pipe lasted four years and a half. We put in also two services of what we call a Stewart pipe, and that lasted six years. That is about as long as it will last, and when you disconnect it you find it is all choked up with rust, and not good for anything. Our lead pipe has always been first-class, so far. I dislike very much to condemn the cement pipe, but I have very little faith in it.

Mr. HANCOCK. — Having used a large amount of wrought-iron, cement-lined pipe, I feel that my experience may be of some benefit to the Association.

The first line of cement pipe laid in Springfield for the water department was put in in the fall of 1864; this line of pipe is eight inches in diameter, and is under a pressure of from thirty-five to forty pounds per square inch; no breaks have occurred on this line up to the present time. Twenty-five years' service and not a dollar's expense argues well for this kind of pipe, and if this was all the cement-lined pipe with which I have had to do, I should be compelled to speak well of it. But it so happens that I have laid a large quantity of it since, a portion of which has not proved as satisfactory. Breaks occur continually, and cause, at times, serious damage.

For the past ten years we have been replacing this pipe with cast-iron.

I find it is universally the case, wherever we dig to and uncover this old cement pipe, that a large per cent. of the cement is soft and lifeless, and the iron badly corroded, in many places entirely eaten away. In removing some sixteen-inch pipe this last spring, which had been laid only about sixteen years, I found it to be badly corroded, the iron being entirely eaten away in spots.

I have never seen a continuous line of five hundred feet of this pipe that was in good condition after it had been in the ground twenty years; single lengths as bright as when first laid are quite often found, but lengths badly corroded are always found.

There may be, and undoubtedly are, places where this pipe may be laid to advantage; it is easily made, and laid, and has no bad effect upon the water.

However, with my experience, I am satisfied that it is not economy to use cement-lined pipes for water conductors, under pressure, in thickly settled towns and cities.

WATER METERS; THE ADVISABLITY OF THEIR USE.

BY

G. A. ROULLIER, Superintendent, Flushing, N.Y.

Establishing satisfactory rates and directing an effective supervision over the use of water constitute two of the important and arduous duties of those in charge of water works. The performance of those duties is frequently difficult and unsatisfactory, because, in the first instance, any system of charging that is not based on actual measurement is arbitrary and must necessarily work injustice to many; and, in the second instance, because inspections, warnings, etc., although they diminish waste, do not stop it. The inspector once out of sight is out of mind.

It seems strange that in view of these difficulties so many managers of works and communities that own works should be opposed to the use of the only instrument or appliance that will at once solve these problems both justly and thoroughly.

As an argument against the use of meters it is frequently said that water should be as free as air, a statement that is fallacious whenever there is a cost attached to the procuring of the water; whereas there is no reason why water should not be dealt out the same as any other commodity, and that each consumer should contribute towards defraying the cost in direct proportion to the benefit he receives. He should pay for all he gets, no more and no less, and certainly none should be allowed to carelessly or wilfully waste that which is costing the community a certain amount to procure.

The water meter is one of the most useful and efficacious instruments in the economical management of water works. It constitutes one of the most important and trustworthy adjuncts of the superintendent's office, doing its duty silently, faithfully, and economically. It acts as clerk and inspector.

Meters once introduced, the constant inspection of premises for changes in the conditions that govern arbitrary rates, and the annoying, tedious, and disagreeable inspections for waste, are at once done away with.

An ever-vigilant watchman, the meter registers at once any increased consumption caused by a change of conditions on the premises, and is an ever-present reminder to the occupants that waste will not go unnoticed.

That this may not be called theoretical and visionary, we will revert to facts, and examine the case of the village of Flushing, L.I.; population, 8,000; system, direct pumping; works, four miles from town; connecting main, 12 inches in diameter; no manufacturing interests of consequence, the place being composed almost entirely of residences. In 1886 the consumption rose to 120 gallons per capita. With a pressure of 75 lbs. at the pumps only 35 lbs. could be maintained at the office during the hours of maximum consumption, — the two gauges being practically on the same level.

In cold weather the consumption during the small hours of the night exceeded that during the hours of daylight. The lack of pressure was complained of throughout the place, and in many of the elevated points in the village the supply ceased altogether during the hours of maximum consumption.

As immediate action was necessary, metering was decided upon, in the face of the bitterest opposition. After considerable trouble 100 meters were set on those services where waste was supposed to be the greatest. The pressure at once rose from 35 lbs. to about 42 lbs., and the daily consumption per tap fell from 754 to 578 gallons.

The benefits derived from these few meters were such that the system was extended, until in 1889 $46\frac{78}{100}$ per cent. of the taps were metered.

During that year the MAXIMUM average daily consumption per tap was the same as the MINIMUM average daily consumption per tap of the year 1886, notwithstanding the fact that in 1889, 232 more services were in operation than in 1886. The annexed table will explain the benefits in detail.

To-day 620 meters are set, and with 70 lbs. at the pumps a pressure of 50 lbs. is readily maintained in the office, and ample service is furnished throughout the village. The coal consumption has been reduced 400 lbs. per day.

On all metered premises the adjustment of complicated rates has been done away with. Disputes as to excessive use of water have ceased. The landlord gets the benefit of any vacancy that may occur in his premises. The consumers are charged according to what they use. The numerous inspections are of the past. Simplicity and economy have taken the place of complication and wastefulness.

TABLE SHOWING ECONOMY EFFECTED THROUGH THE ADOPTION OF THE METER SYSTEM AT THE FLUSHING WATER WORKS.

G. A. Roullier, Superintendent.

	1886.		1887.		1888.		1889.	
	Average number of gallons used daily per tap.	Per cent. of taps metered.	Average number of gallons used daily per tap.	Per cent. of taps metered.	Average number of gallons used daily per tap.	Per cent. of taps metered.	Average number of gallons used daily per tap.	Per cent. of taps metered.
January	781	0.61	809	0.68	588	15.41	521	19.73
February	837	0.61	691	0.68	586	15.75	574	20.38
March	685	0.60	650	0.67	581	15.75	522	22.43
April	572	0.60	574	0.78	523	15.81	460	33.71
May	617	0.59	584	9.41	509	16.47	481	39.45
June	754	0.70	578	12.11	561	16.82	478	42.62
July	778	0.69	570	12.88	587	16.74	487	44.83
August	734	0.69	534	13.34	583	17.01	454	45.62
September	716	0.68	509	13.88	508	17.27	445	45.85
October	677	0.68	460	14.85	490	18.33	416	46.20
November	605	0.68	472	15.16	404	18.78	416	46.68
December	753	0.68	496	15.43	516	19.28	410	46.78

Mr. FITZGERALD. — I am one of those who believe that the proper way to distribute water to the consumer is through a meter. For a number of years now

I have been of that opinion, and every year adds to the strength of my belief. In the town in which I live I had occasion, about three years ago, to take the ground strongly that the extension of the water works should not be carried on till something was done in the way of putting on meters to stop the waste, the waste was so enormous. That is the common experience. We hardly ever take up a report from any part of the country in which we do not see complaint of the same thing. It seems to be the common experience of every superintendent and every manager of water works. Water is a commodity, and the price should be regulated, or the cost to the consumer, by the amount that he uses. It seems to me that is the only fair and equitable basis for the adjustment of rates. I might finish what I started to say a moment ago with regard to the town in which I live, by saying that we succeeded in getting a meter system adopted, and the result has been to keep the consumption down at the present time to what it was a number of years ago, so that instead of its increasing in a very marked way, as it probably would have done, it has been nearly level.

Mr. BILLINGS. — It is a good while since I have had an opportunity to take part in any discussion of this nature, and what I say now will be very brief, and I shall say it as much for my own pleasure as for yours. One thing occurred to me as the gentleman was reading his interesting paper, and that is, that although he showed very clearly that in the case of Flushing great improvement was noticed, and many troubles and evils were gotten rid of, yet, I may suppose, perhaps he has been exceptionally favored. Because, in my experience, at least, although meters did do away with some troublesome things, each meter brought its own evils with it. Meters have to be taken care of, and are a source of annoyance, and I could never find a way to get rid of the grumblers who never could be quite sure that the meter was doing them justice, but who would come with perfect confidence that the meter was wrong and was doing them great injustice, when the bills were larger than they had been, and that the meter ought to be changed. However, I am free to confess that evil is not so great as the evils with which the meter dispenses. One more point occurs to me. I left the charge of a water department with a belief, which I have had no occasion to change,— and I should like to know if active managers to-day agree with me,— that in naming over the qualities which should be found in the most practical and on the whole most satisfactory meter, perfect accuracy is not the first quality required. On the other hand, simplicity and permanence of conditions are the important things. If there be a slight error, let it be a constant error. Simplicity and permanence are of more value than absolute accuracy. I have had a feeling that a meter which would register within one or two per cent. of the truth, and keep that error within reasonable limits, if it were a cheap meter and easily taken care of, is a more valuable machine to the water department than one which with great care may be made to register day in and day out without any appreciable error. If that is a false position and a mistaken idea, I should be very glad to hear it controverted.

Mr. ROULLIER. — A meter really acts as a sort of conscience for the community. The consumption ran down materially with us before we put a single meter in, when we were merely speaking of putting them in, because every man was going around and telling his neighbors it was a perfect shame to waste the water as they were doing. So I believe if you have a meter that will come within a certain degree of accuracy, you have all that is wanted.

Mr. CHACE. — I had a little experience a year or two ago with a meter that may be somewhat interesting. A gentleman came to me very anxious to have his meter changed; it was a Crown meter, and he was very sure it was over-registering, so he wished to have it changed, and another kind of a meter given to him, — another make. Out of motives of courtesy I won't mention the kind which he suggested. I asked him if he really desired to pay for less water than he used. He was not willing to say that, and, after talking with him some little time, I was so thoroughly satisfied in my own mind what the result would be if any change was made, I finally told him, knowing that the meter had been in use some five or six years, I would take out his meter and have it tested, and if it registered one-half of one per cent. over the proper amount I would take out the Crown meter and put in the other kind. The Crown meter was taken out and tested, and the result of it was, it having been in use this length of time, as might naturally be supposed, it under-registered about four per cent. Without telling him this part of it we told him the result of the registering, and put it in proper repair, changed the wheels somewhat so it slightly over-registered, perhaps half of one per cent., and let the thing go. (Laughter.)

The PRESIDENT. — I should like to ask for my own information what the experience of the members has been as to the life, putting it in that way, of a five-eighths meter, and I should assume the life would not be given in length of time but in quantity of water delivered. And I might perhaps go a little further and say from my own experience that the meters which have passed from three to five hundred thousand cubic feet, meters of that size, will under-register from four to ten per cent. I should like to know if that coincides with the experience of other people. Of course you will find exceptions to that rule in a great many cases. You might find a meter which has registered a million feet which will be within one or two per cent., but that will be the exception rather than the rule. On the other hand you will find a meter which has passed, it may be, only a hundred thousand feet, which will be ten per cent. out of the way, and that would be an exception in the other direction. If there happens to be a small particle of grit of any kind get into the meter and start a grinding action, that may continue even after that particle passes through the meter. Our policy is to take out the meters after they have passed from three to five hundred thousand feet and test them. Some of them go back and some of them are repaired.

Mr. WHITNEY. — What do we understand by your expression the "life" of a meter? Do you mean the ordinary duty which it will perform before it will be necessary to make some repairs upon it?

The PRESIDENT. — That is what I mean.

Mr. WHITNEY. — I should think unquestionably a five-eighths meter, after passing three to five hundred thousand feet, would under-register, as you say, and that it might under-register ten per cent. It certainly would require repairs at that time, but the repairs could probably be made cheaply on most meters, and would cost but a small percentage of the original cost, so it could hardly be said that that was the life of the meter, because the cost of the repairs at that time could fairly be put down as cost of the maintenance of the meter.

The PRESIDENT. — I used the term "life," perhaps, in a way that might be misinterpreted. I agree entirely with your interpretation.

Mr. FITZGERALD. — Aren't there any opposers of meters here?

Mr. BILLINGS. — I run across a fact yesterday which helps to explain why the Portland Water Company is so popular. I was told that they don't shut off the water if a man does not pay; they furnish 200 gallons per capita, and they don't believe in meters. (Laughter.)

The PRESIDENT. — Mr. Nevons is a gentleman who does not use a great many meters, and we would like to hear from him.

Mr. NEVONS. — I think I will pass on the meter question, Mr. President. (Laughter.)

Mr. WALKER. — I will tell a little story. A man came into my office a year ago, and said he, "Charles, I believe I will have on a meter." — Said I, "What do you want a meter on for; how much do you pay now?" — He says, "Fifteen dollars." — Said I, "You will have to pay twelve any way if you put a meter on, and I wouldn't have it on if I was in your place." — "Now," said he, "I can just as well save that three dollars as not." — Said I, "Suppose it gets away from you some time when you are away?" — He says, "Oh, I guess that will be all right, I won't bother about that." — Said I, "I wouldn't put it on, I tell you." — "Well," said he, "go ahead and put it on, I will take the risk." The first three months the bill was considerably high and he walked into the office and says, "This is highway robbery (laughter); I haven't used any such amount of water. I know what I am talking about." — "Haven't you got a leak?" — "No, sir; no leak there," said he; "not one, and you can take that meter out as soon as you want to, I don't want any more of it." (Laughter.) — I said, "I can't do it now; you go and look the matter over a little and see if there isn't a leak there somewhere. I am sure of it," said I, "and you can tell by going down into the cellar and watching the meter, and if that little small hand is going around all the time when the faucets are shut, you can bet there is a leak somewheres, and," says I, "if there isn't any leak you let me know and I will come up and take the meter out." He came down the next morning, and as he came into the office, I said "How is the meter?" — "You needn't come up; I've found it." (Laughter.)

Mr. RINGROSE. — I think I could beat Mr. Walker's story a little on meters in a case which happened in my town. The Opera House Company had been paying $46 a year, and there were four or five rooms in the building became vacant, and they thought they ought to get a little reduction, and they came before the board, and the board put down the rate to $20 for six months, making it $40 a year. They thought they were being robbed at that rate, and for about a year and a half they have been asking for the meter. The board was not ready to grant meters until a year ago, when they became satisfied that it would be well to put in meters wherever applied for, and at that time the Opera House Company put in a very earnest application for a meter. They were only using the water for the opera house and in two stores. So a meter was put on, and in the first three months it registered $39.50 worth. (Laughter.) Ever since then the trouble has been that they have wanted us to take the meter out.

The PRESIDENT. — One of the topics for discussion is so intimately connected with this subject that I would suggest it be taken up at the present time. It is "Should the meters used be owned by the water-taker?"

Mr. ALLIS. — I would like to ask, for information, what the general practice

is in regard to this matter. I understand from what I have heard here that in some places where meters are put in the water-taker is charged $15 as a minimum rate. Does that charge include everything, or is there a charge also for the water? We don't put in meters as a usual thing, except for manufactories and stables and such places, and we make them pay so much for the meter and they then own it, and then we charge them so much for the water. I should like to know what the usual custom is.

Mr. CHACE. — I will state what the practice is in Taunton. We have a minimum rate of $10 a year for the use of the water, and we have a fixed price of $15.50 for a five-eighths meter and $20.50 for a three-quarters meter, and put in whatever sort of meter they want, as a rule. Those meters are put in at the expense of the owner, the owner paying us for the meter at his convenience, allowing him three months if he desires. But the water department also reserves the right to put in a meter at any place it sees fit at its own expense, if it has any reason to suppose a consumer is using more water than he is paying for, and there are several places in town where there are meters that belong to the department. Some of the large consumers have quarterly rates for meters that belong to the department, and the department changes such meters whenever it chooses.

Mr. WHITLOCK. — I think, perhaps, our method is different from that in most other places. Our water department owns and maintains all its meters. They are put in without any charge, except in cases where there is a very small use of water; in such cases a nominal rental is charged, in addition to the water bill, or the use of the meter. We have a rule which specifies that no user from a meter shall be charged less than the minimum amount for an ordinary family use. We have two methods of charging for water, — one by which the price is governed by the occupants in a house, or by the occupants and also by the fixtures, and the other by the meter; and in no case is the meter rate allowed to run below the minimum for the ordinary family.

Mr. RINGROSE. — I would like to mention still another way. In my town we have an entirely different system of meter service. The meter is owned and controlled by the city or by the water department, and we receive a rental for the meter. We charge ten per cent. on the cost of the meter and the cost of putting it in, — ten per cent. annually, and retain full control of the meter.

Mr. WHITNEY. — Our minimum rate in Newton is ten dollars a year, with a charge at present of two dollars a year for a meter, the city keeping the meter in repair except in case of freezing. We find it to be a very satisfactory system, and it operates with very little friction. Of course there is really an advantage in the city's controlling the meters and renting them at a certain fixed rate, in that the water-taker knows precisely what the meter is costing him. If he buys and pays for his own meter he is at the expense of the interest on his money, which he loses, and he is also liable for the expense of the repairs, which, of course, is a very uncertain thing; he cannot tell what those may cost him. Under our system he knows just what he is to pay, and it has proved to be very satisfactory indeed.

The PRESIDENT. — I should suppose when the meters are owned by the water-takers they would have very little interest in keeping them repaired.

Mr. WHITNEY. — That shows, of course, the benefit to the department in owning the meters itself.

The PRESIDENT. — I think that has been a trouble they have experienced in Worcester. I don't know as there is any member present from that city. The meters there have been owned by the water-takers, and the water department has had great difficulty in seeing that they were kept in proper repair. In Boston all the meters are put in and are owned by the city. Dwelling-houses are not metered, except in cases where there are six or eight families in a building. In cases where water is used for power, that is, in running water motors and elevators, which would be similar, where we are obliged to put in a very large meter in order to give the requisite pressure and flow, the parties are obliged to pay a rental; but in other cases they do not pay any rental.

Mr. FULLER. — I would like to ask for information whether, in case a man owns several residences, he should be allowed to furnish water for all those houses through one meter, supposing he had three or four different houses.

Mr. CRANDALL. — We have one instance in Burlington where, a man furnishes seventeen families through one pipe.

Mr. HAMILTON. — We charge a rental of ten per cent. on our meters, and we determine where to put them. We put them in for all large consumers; for instance, hotels, manufactories, and warehouses where there are water-closets. We furnish the water for so much a thousand, and charge ten per cent. for the rent of the meters. In case a gentleman wanted to supply a number of houses, it wouldn't cost him any more, for after we put the meter on he can supply anything he likes.

Mr. HAWES.— In our place we have between three thousand and four thousand meters in use, and every taker owns his own meter, and we don't charge him anything for it.

Mr. ALLIS. — I would like to ask the gentleman, who repairs the meters?

Mr. HAWES. — We have a very nice meter, and the majority of them don't come in for any repairs. (Laughter.) If a taker thinks his meter is out of order we take it out and test it, and if it is all right he pays us a dollar for the trouble of taking it out and putting it in again. If it does need repairs he pays for the repairs on it before it is put back. At the same time, if we hadn't got into it so deep as we have now, I wouldn't recommend such a system. I am a good ways from home and so I can say it. (Laughter.) But we have so many meters that it would cost us about fifty thousand dollars to buy them from the takers, and we wouldn't want to make such a large investment in second-hand meters. If I was to start over again, I should recommend the city to own the meters and then charge a rental for them; but having got into it so far we can't get out of it, and so we have to claim that it is best for every taker to own his own meter. (Laughter.)

The PRESIDENT. — Do I understand Mr. Hawes to say that meters are repaired only at the request of the water-takers?

Mr. HAWES. — That is all. If they are out of order the takers have to pay for more than when they are in order; and if they don't find any fault, we don't. (Laughter.)

Mr. ALLIS. — The more I hear about meters the more muddled I get.

Mr. HAWES. — That is the case with the meters, too. (Laughter.)

Mr. ALLIS. — I begin to think now it is a good deal with water meters like it is with gas; we always suppose the gas people are going to send in a bill whether

we use any gas or not. In Malden we have discussed the meter question quite a little, and have been very conservative about going into their use. Some people come in and say they haven't any meters and insist upon having them, and then others come in and say the rate is too high and they don't want the meter. That is why I asked what the general practice is. None of you seem to agree exactly, and I should like to see all the different methods put down on paper, and to know what the experience with them has been. I confess it does seem to me that it is the best plan for the city to own the meters.

Mr. WALKER. — That's so; you've got that right. (Laughter.)

Mr. ALLIS. — That is what I think. Let the city own the meters and charge a rental, and then charge for the water; and if it is not getting enough money then, charge a little more.

Mr. WOODRUFF. — I would like to ask the gentleman who said that meters always over-read, if he has some special kind of a meter?

Mr. HAWES. — The people never complain that the bills are too small. (Laughter.)

Mr. WALKER. — We have tried a number of different ways, — charging rent, ten per cent. on the cost, and all that sort of business, — and finally we concluded to put in the meter and call it twelve dollars. So we put in a meter, and if it don't run we take it out. Suppose it don't register at all, why then you can take it out, and nobody can tell you that it's all right and you mustn't touch it. If they own a meter they will tell you it is all right, that they haven't been at home, that they have been away from home, that the meter is all right only they haven't used any water. There isn't but one way to do about this meter business, — because I have been through it all, and my opinion is as good as Hawes' (laughter), — and that is for the city to own the meter, and then if it don't work right they can take it out and put in another until they get it right. That is the most satisfactory way, in my opinion. Now, Mr. Hawes, if you have got anything to say, say it, and don't get mad about it. (Laughter.)

Mr. HAWES. — That is all right; but our meters I think, are built on the same principle as the gas meters, for we have continual complaints that they register right along whether the family is in town or out. (Laughter.)

The PRESIDENT. — I might say I have actually known of a case where there was more water used in the night in a building where there were no people at night, than there was in the daytime when people were there. It was a large business building in which there was between a dozen and twenty water-closet tanks, and in almost every one of them the ball-cock was out of order, so that they were wasting continuously, and during the night there was so much more pressure that more water ran than during the daytime. And that was a building where they had been paying the bills for some time without any particular complaint.

Mr. ROULLIER.— We make the consumer buy the meter and we take care of it. By that method we are always sure that the meter is in order, and we haven't the slightest fear of the taker interfering with it.

The PRESIDENT.— In case the meter wears out, you replace it?

Mr. ROULLIER.— Yes, sir.

The PRESIDENT.— I might say I have known of a great many cases where it would be economy for the city to take out a meter and replace it, rather than

to allow the continued use of a meter by which they were losing from 40 to 50 per cent.

Mr. FILBURN.— I don't know why it wouldn't be economy for the city to let it remain, if the meter is the kind Mr. Hawes uses, which always registers more when it is out of order.

The PRESIDENT.— I must say Mr. Hawes' experience is something new to me.

Mr. WALKER.— It is new to me, also. I never took one out in my life but what went back on the city.

Mr. HAWES.— Those that register too much are the only ones we have any complaints from. (Laughter.) We don't hear anything from the others.

Mr. CHACE.— It has been my experience that in nine cases out of ten, perhaps ninety-nine out of one hundred, if a meter is in error, it is in favor of the consumer. If we find it is in favor of the water department, no matter how little, we acknowledge it, and if it is enough to amount to anything we make an allowance on the bill. As I think I said in a paper I read before you once, we have the meters read every month, and if we find the meter is reading more than the average consumption of the consumer, we notify him, so that in case there are any leaks he can look them up and have them repaired. And if we find it is considerably less than the average, without asking any permission from him or saying anything about it, we take it out and put it in order.

The PRESIDENT.— And send him the bill?

Mr. CHACE.— No, we do not charge anything for that. We never charge for any repairs on the meter unless it is injured by freezing.

RECORDING GAUGES.

BY

JOHN A. GOULD, Jr.

The value of carefully kept water-works records needs no special advocate before members of this Association, as the persons responsible for the proper management of every well-regulated supply not only believes the fact, but, I am glad to say, generally practise what they believe.

I have been asked to speak of some of the mechanical devices used upon the works with which I am connected, to record what may be called the physical condition of the various departments of our water-supply.

These daily records may be divided into four groups: First, the records relating to the sources of supply, as the rainfall, storage in reservoirs and lakes, waste over dam, amount drawn from the lakes, etc., from which the yield of the water-shed can be calculated; second, the amounts received into and drawn from the distributing reservoirs, the amount pumped by the different engines, the pressure or loss of head in the mains, etc., from which the water consumed and the general condition of the distribution system may be ascertained; third, the multitude of observations incident to a modern pumping-station, from which the economy of the pumping-plant is ascertained; and, fourth, the meteorological observations which communities of any considerable size owe to that branch of science. A fifth might be added for the newly developed branch of biological research.

Any one who has been in charge of a series of observations for any length of time is probably aware that errors may be made by the different observers, and the records sent to the office may be decidedly different from what one's judgment would lead him to expect.

At this point recording gauges may often be advantageously employed, not to wholly supplant the individual observer, but to confirm his statements, perhaps, and be a silent witness at all hours of what is taking place in its own special line.

But the greatest advantage derived from these gauges over observations taken at intervals is that they are on hand when anything unexpected or unusual occurs, which would probably be missed by the observations taken at stated hours.

This paper does not pretend to cover the whole subject, nor include all varieties of recording gauges, but will mention some that have been used in Boston, and thus open the question for a general discussion.

During the development of the Sudbury-river supply, some ten or fifteen years ago, a recording gauge was used in gauging the flow of the river. The height of the water was recorded on an endless roll of blank paper, which was drawn by rolls moved by clock-work across a horizontal board. A copper float, resting upon the surface of the water, moved the pencil by means of a cord, which, passing over a pulley, transmits its motion, by means of a geared wheel, to the horizontal rod on which the pencil is attached. The vertical scale could be varied from full size to one-eighth size by means of different diameters of the pulleys over which ran the cord from the float.

Gauges were afterwards placed in the different gate-houses of the completed conduit. On these, the paper was attached to a vertical drum, which was revolved by clock-motion. The variations in the height of the water were recorded at full scale by a pencil which was connected with a copper float by means of a vertical rod. The height of the water in the conduit being under absolute control, the records could be made with this large scale on a comparatively narrow sheet of paper, as the position of the pencil could be moved some even foot on the float-rod to accommodate any desired depth in the conduit.

A gauge was subsequently used in which the drum was raised and lowered to accommodate the different depths flowing in the conduit. This is carefully set by means of a tangent screw, and the exact height is found by means of a water column of known elevation.

From the diagrams obtained by these gauges, the average depth of the flow is obtained by means of a planimeter, and the greatest possible accuracy is thus obtained.

To ascertain the pressure in the distribution-pipes, two kinds of commercial recording gauges have been used, — the Edson and the Peerless.

The Edson gauge records the pressure in pounds per square inch, upon a continuous profile paper. The Peerless records the pressure in pounds per square inch upon a circular dial, which should be changed once in twenty-four hours. The latter is used on both the high and low service distribution in the city, and similar gauges record the steam-pressure in the pumping-stations. Inking-pens have recently been attached to the Peerless gauges, and the frictional contact on the diagrams is reduced to a minimum.

A special gauge was designed about twelve years ago, to indicate the actual

head of water in one of the larger mains in the city proper. This gauge was located in the old Beacon-Hill reservoir, then not in use, and since torn down. This reservoir was formerly connected with the low-service distribution, and was at such an elevation that a float connected with the gauge could rest directly upon the surface of the water, within a 6-inch stand-pipe. This pipe was connected with the 30-inch main by a $\frac{3}{4}$-inch lead pipe.

The gauge consists principally of two horizontal drums, operated by clock-work. The blank paper is drawn from one drum to the other by a clock-motion, passing in contact with the pencil that is moved, at a reduced scale, by a copper float. This float rests upon the surface of the water within a 6-inch stand-pipe, and rises and falls with the varying loss of head in the mains.

A cord from the float passes over a 6-inch pulley, and the motion is transmitted to the pencil by means of a spiral gear engaging with a rod, to which the pencil is attached.

This gauge was in use about four years, or until the reservoir was torn down. The smallest variation in the pressure was recorded by this gauge on a vertical scale of one-eighth of an inch to a foot, and made a most interesting record of the effect of shutting the various gates, the blowing off of mains, the starting and stopping of the high-service pumps, the loss of head during fires, etc.

A series of observations, taken every thirty minutes for ten consecutive days and nights, at the reservoir in Brookline, established the rate of consumption for various losses of head in the mains, as indicated by this gauge. Starting with the well-defined results established by these observations, a table was extended to cover drafts of from 11,000,000 to 40,000,000 gallons in twenty-four hours, by the formula $Vh : Vh' :: Q : Q'$ in which h and h' represent losses of head in the mains, and Q and Q' the corresponding rates of consumption. This made a most convenient method of determining the rate of consumption at any desired moment by simply observing the loss of head shown by the gauge and noting the corresponding flow in the table.

When Beacon-Hill reservoir was removed, there was no convenient place where a gauge with its float resting directly upon the surface of the water could be located. This necessitated a new design, with the float resting upon a mercury column. The well-known principle of a bent mercury column being used, the gauge can be designed for any pressure. The one now described was located on the Common, near the junction of the 40-inch and two 30-inch mains.

To reduce the vertical scale to the desired $\frac{1}{4}$-inch to a foot, cylinders of different diameters were attached to the two ends of the mercury column, the cross-section of the upper one, which contained the float, being about two and one-half times that of the lower one. The pencil is attached to a rod which is moved directly by the float, without any further reduction in its movements.

A continuous sheet of blank paper is reeled from one vertical drum to another by a clock at the rate of 18 inches in 24 hours, and passes in contact with the pencil.

The records from both of these gauges, being made on blank paper, have to be worked up in the office whenever the leisure time may present itself; the value having such an accurate record of the loss of head in the supply mains, under all conditions, more than repays the trouble and expense of its maintenance. Graduated diagrams could be used if it were convenient to visit the gauge at some regular hour every day.

The necessity of having some indicator in the pumping-station to show the height of water in the reservoir or stand-pipe has probably impressed itself upon every one responsible for the proper running of such works. The number of times the high-water line in stand-pipes has been drowned is known only to those on the "inside," and cases have occurred where the water in the reservoir has been practically exhausted, while the engineer has been ignorant of the fact.

When the temporary high-service works were started in Brighton in 1876, an electric indicator, designed by Mr. Thomas Hall, of Boston, was put in operation. This indicated, at the pumping-station, the height of water in the reservoir, but did not register the same.

Last fall an electric apparatus that indicates and registers the height of the water in Breed's-Hill stand-pipe was placed in the new station in East Boston, which is two miles distant. This gauge was designed by our fellow-member, Mr. George E. Winslow, to protect the works under his supervision from the second occurrence of what nearly chanced to be a catastrophe, and proving to be a success, he has been persuaded to allow his friends to use the same device, for a proper consideration. The one in Boston has been in use over six months, and thus far has been a perfect success.

An instrument similar in general appearance to the Winslow gauge has been placed in the Chestnut-Hill pumping-station during the present week, to indicate the height of water in Fisher-hill reservoir, and is now in successful operation. This instrument is known as the telehydro-barometer, and was made by the Standard Thermometer Company, of Peabody, Mass.

With either of these recording instruments, and a good mercury gauge on the force-main for a check, I see no reason why the high-water line in covered reservoirs and stand-pipes may not be established two or three feet higher than has usually been considered safe, and thus practically save the cost of an instrument.

To indicate the height of water in tall, uncovered stand-pipes, the float of the transmitter might rest upon a mercury column similar to that used upon the Boston Common gauge, before described. The gauge being connected with the stand-pipe by an underground pipe, the whole apparatus could be protected from frost by a building small enough to be heated by a kerosene lamp.

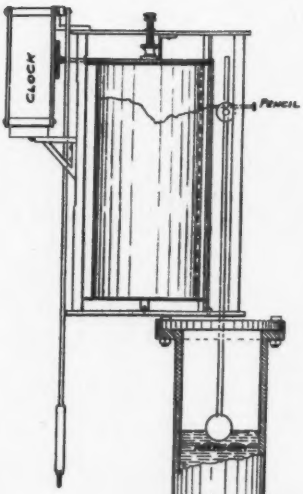
A transmitter which is operated by water pressure is made by the Standard Thermometer Company, which is said to accomplish the same result.

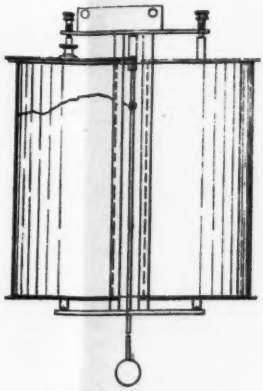
While speaking of pumping-stations, the value of a gauge to record the steam-pressure in the boilers cannot be overestimated. As before mentioned, the Peerless gauge is used for this purpose.

The work of the different shifts of men is shown at a glance, and the firemen can be brought to feel a just pride in keeping the steam-pressure to within one pound's variation.

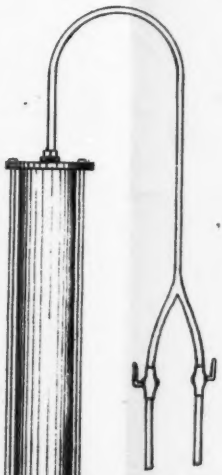
An article in a recent daily paper gave an account of a very mysterious quality of steam that instantly increased the pressure in the boilers some 50 or 100 pounds above that usually maintained, and thus accounted for many boiler explosions.

I think it is safe to say that these mysteries never occur when there is a recording gauge connected with the boiler. There is more mystery connected with the actions of some firemen than with the steam itself, and a recording steam-gauge may dispel even that.



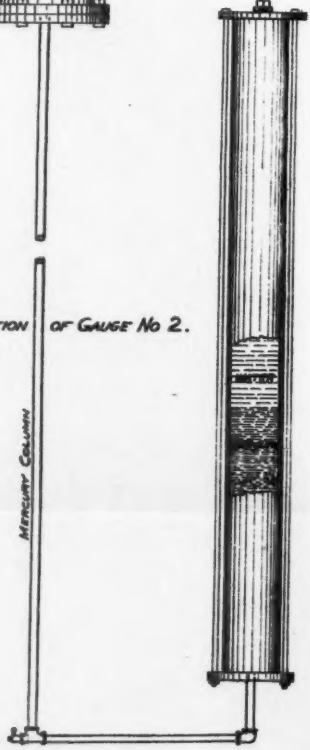


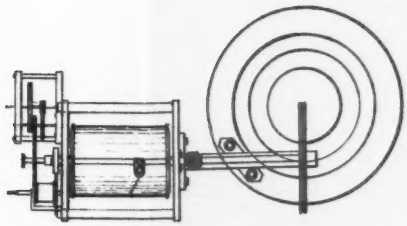
ELEVATION OF DRUMS.



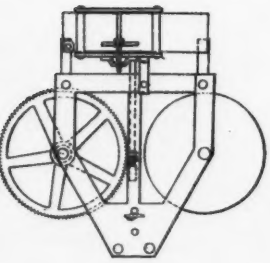
CONNECTIONS WITH MAIN PIPES

ELEVATION AND SECTION OF GAUGE No 2.





PLAN OF No. 1.



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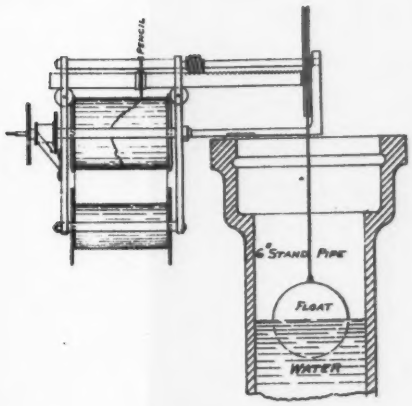

ELEVATION AND SECTION OF GAUGE No. 1.

BOSTON WATER WORKS.

PLAN OF TWO GAUGES FOR RECORDING THE LOSS OF HEAD IN MAIN PIPES.

SCALE 3 INCHES TO 1 FOOT.

A variety of recording instruments are used in connection with the meteorological observations at Chestnut-Hill reservoir.

A recording rain-gauge of an original design has been used for several years. The gauge proper was located on top of a small office building, from which the rainfall was conducted through a small pipe to the registering portion of the gauge in the office below. A float, to which a pencil is attached, is placed in a vertical cylinder, and is raised by the impounded rainfall. The paper is placed on a single vertical drum, which is revolved by a clock-motion once in twenty-four hours. The record is made at twice the natural scale.

Another gauge, designed by Mr. S. P. Ferguson, of the Blue Hill observatory, has been used for several months. This is a compact instrument, and registers the rainfall accurately. The rainfall is weighed by means of a spiral spring, and the amount is recorded on a paper diagram attached to a vertical drum. An ink pen is used, which is moved by a parallel motion connected with the spring. This gauge is now upon the market, and is a valuable acquisition for any one interested in such work.

A carefully constructed apparatus to register the evaporation from water surfaces was designed at this station in 1884.

A paper is placed on a horizontal board, which is moved by clock-work at the rate of two inches in twenty-four hours. A pencil records the evaporation, or the lowering of the surface of the water, on a scale four times the actual amount. This increase in scale is accomplished by passing the cord from the float over a small pulley, and using a larger one for the cord that moves the pencil.

The records from this instrument can be read easily to $\frac{1}{100}$ of an inch. Particular care was taken to remove as much of the friction as possible, the truck that carries the pencil having agate bearings. The actual friction is equivalent to an error of $\frac{1}{100}$ of an inch in the record.

A registering thermometer, or thermograph, made by Richard Frères, of France, gives a very interesting profile of the range and variations in the temperature for each week.

A hygrometer, to register the humidity of the air, made by the same party, and an electrical anemometer, which was made by A. Hahl & Co., of Baltimore, complete the list of registering instruments in use upon our works.

The accompanying cut shows two of the gauges used in ascertaining the loss of head in the distributing mains. A cut and description of the apparatus used in gauging the flow of Sudbury river can be seen in Transactions of Am. Soc. of C. E., No. 224, in a paper by Mr. A. Fteley. The instrument to register the evaporation is illustrated in No. 340 of the publications of the same society, a paper by Mr. Desmond FitzGerald.

I have not considered it necessary to give the details of the commercial instruments mentioned in this paper. The agents of the manufacturers are probably not unknown to a majority of the members, and some of the instruments can be seen in the adjoining exhibit.

In regard to the special gauges that have been designed by engineers employed by the Boston Water Works, I would make one suggestion; if any one proposes to build one of them, don't use too cheap a clock for a motor. The actual working of the gauges described can be better understood by an examination of the diagrams taken from them, which I have brought with me.

New England Water Works Association Membership Roll.

September 1st, 1890.

NOTE.—The secretary requests to be advised of existing errors or changes of address from that which appears in the following list.

ACTIVE MEMBERS—RESIDENT AND NON-RESIDENT.

Alexander, George
Commissioner of Public Works, Quincy, Mass.

Andrews, Frank A.
Assistant Superintendent, Nashua, N. H.

Allen, Charles A.
City Engineer, Worcester, Mass.

Allen, Charles F.
Treasurer, Hyde Park, Mass.

Allis, Solon M.
Superintendent, Malden, Mass.

Ayres, Henry W.
Chief Engineer, Hartford, Conn.

Babbidge, P. F.
Superintendent, Keene, N. H.

Babcock, Stephen E.
Hydraulic Engineer, Little Falls, N. Y.

Bacot, R. C., Jr.
Superintendent Meter Department, Hoboken, N. J.

Batchelder, George E.
Registrar, Worcester, Mass.

Bagnell, Richard W.
Superintendent, Plymouth, Mass.

Ball, Phinehas
Civil Engineer, Worcester, Mass.

Baldwin, Charles H.
Box 2410, Boston, Mass.

Bancroft, Lewis M.
Chairman Water Commissioners, Reading, Mass.

Barns, Everett
Superintendent, Westerly, R. I.

Barrett, Albert P.
Water Registrar, Woburn, Mass.

Bassett, Carrol Ph.
Civil Engineer, 784 Broad street, Newark, N. J.

Battles, James M.
122 Webster street, East Boston, Mass.

Bayles, James C.
Hydraulic Engineer, East Orange, N. J.

Beals, Joseph E.
Superintendent, Middleboro, Mass.

Belcher, J. White
Water Commissioner, Randolph, Mass.

Bickford, Nathan B.
Superintendent Water Works, O. C. R. R., Boston, Mass.

Billings, Wm. R.
15 Harrison street, Taunton, Mass.

Birkinbine, Harry
Superintendent, Council Bluffs, Iowa.

Bishop, George H.
Civil Engineer, Middletown, Conn.

Boggs, Edward M.
Hydraulic Engineer, San Bernardino, California.

Bolling, Charles E.
Superintendent, Richmond, Va.

Brackett, Dexter

Superintendent Eastern Div. Boston W. W., 221 Federal street, Boston, Mass.

Brady, John G.

Commissioner, Worcester, Mass.

Brainard, C. M.

Manager, Skowhegan, Maine.

Brand, Junius A.

Superintendent, Norwich, Conn.

Brinsmade, Daniel S.

Civil Engineer, Birmingham, Conn.

Broatch, J. C.

Superintendent, Middletown, Conn.

Brown, A. E.

Assistant Superintendent, Milford, Mass.

Brown, Arthur W. F.

Registrar, Fitchburg, Mass.

Brown, Edward H.

Superintendent, Nevada County N. G. R. R., Grass Valley, Cal.

Brown, J. Henry

3 Tremont street, Charlestown, Boston, Mass.

Brush, Charles B.

Engineer and Superintendent Hackensack Water Company, 1 Newark street, Hoboken, N. J.

Burnham, Albert S.

Superintendent, Revere, Mass.

Burnie, James

Superintendent, Biddeford, Me.

Caldwell, Joseph H.

Registrar, Mystic Division, Charlestown, Boston, Mass.

Carroll, F. B.

104 Pequot ave., New London, Conn.

Cate, E. W.

Water Commissioner, Newton, Mass. Address 113 Devonshire street, Boston, Mass.

Chadbourne, E. J.

Superintendent, Holbrook, Mass.

Chandler, Charles E.

City Engineer, 161 Main street, Norwich, Conn.

Chandler, Charles F.

Professor of Chemistry, School of Mines, Columbia College, New York city.

Chaplin, W. S.

Professor of Engineering, Harvard University, Hammond street, Cambridge, Mass.

Chase, George F.

Superintendent, Taunton, Mass.

Chase, H. S.

Superintendent, Great Falls, N. H.

Chase, John C.

Superintendent, Wilmington, N. C.

Childs, Wm. H.

Superintendent and Secretary, Manchester, Conn.

Clark, D. W.

President Water Company, Portland, Me.

Clark, Ezra

President and Superintendent, Hartford, Conn.

Clark, Jonas M.

Superintendent, Northampton, Mass.

Clifford, Walter

President Water Board, New Bedford, Mass.

Coburn, Walter

19 Congress street, Lowell, Mass.

Cochran, Robert L.

Superintendent, Nahant, Mass.

Codd, William F.
Superintendent, Nantucket, Mass.

Coffin, Freeman C.
Assistant with M. M. Tidd, 10 Tremont street, Boston, Mass.

Conant, H. W.
Superintendent, Gardiner, Mass.

Conant, Whitney
Secretary Water Co., Long Branch, N. J.

Coggeshall, R. C. P.
Superintendent, New Bedford, Mass.

Cook, Byron I.
Superintendent, Woonsocket, R. I.

Crehore, Dr. C. F.
Box 1252, Boston, Mass.

Crandall, F. H.
Superintendent, Burlington, Vt.

Crilly, P. F.
Superintendent, Woburn, Mass.

Crockett, A. F.
President Water Co., Rockland, Me.

Croes, J. J. R.
Civil Engineer, 13 William street, New York city.

Cunningham, W. B.
Superintendent, Trinidad, Col.

Cushing, Lucas
Assistant Superintendent, 221 Federal street, Boston, Mass.

Darling, Edwin
Superintendent, Pawtucket, R. I.

Davidson, James
Superintendent, Box 246, Central City, Cal.

Davis, Charles S.
Water Commissioner, Plymouth, Mass.

Davis, F. A. W.

Vice-President Water Co., Indianapolis, Ind.

Davis, William E.

Superintendent, Sherburne, N. Y.

Dean, Francis W.

Mechanical Engineer, 27 School street, Boston, Mass.

Dean, Seth

Civil Engineer, Glenwood, Iowa.

Decker, J. H.

Secretary, Treasurer, and Manager, Salina, Kansas.

Denman, A. N.

Secretary and Manager, Des Moines, Iowa.

Dennett, Nathaniel

Superintendent, Somerville, Mass.

Denton, J. E.

Professor of Experimental Mechanics, Stevens Institute, Hoboken, N. J.

Dewson, F. A.

Water Commissioner, Newton, Mass. Address Box 1534, Boston, Mass.

Diven, J. M.

Secretary and Treasurer Water Co., Elmira, N. Y.

Dixon, William

Superintendent, Mt. Pleasant, Mich.

Doherty, Philip J.

Member Water Board, Boston, Mass.

Dotten, William T.

Superintendent, Winchester, Mass.

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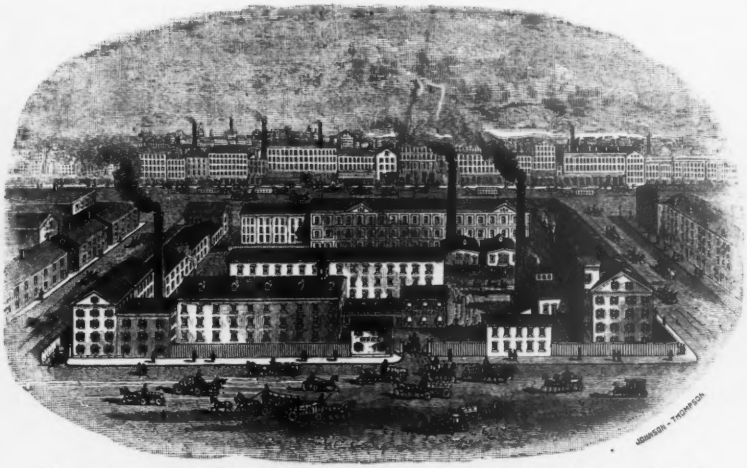

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NEW YORK.

EUREKA FIRE HOSE CO.

No. 13 Barclay Street, New York.

THE LARGEST MANUFACTURERS OF

RUBBER LINED COTTON HOSE

of all Descriptions, in the United States or elsewhere.

Sole Manufacturers of the Celebrated Brands of Seamless Woven Cotton, Mildew Proof and Rubber Lined

FIRE DEPARTMENT HOSE.

"EUREKA," a Triple Hose.

"PARAGON," a Double Hose.

"RED CROSS," a Single Hose.

Manufacturers of HOSE of every description.

SOLE MANUFACTURERS OF

"EUREKA UNDERWRITERS"

BEST LINEN HOSE,

made in accordance with the requirements and specifications of the

Associated Factory Mutual Insurance Companies for Factory Linen Fire Hose.

Every length of the "Eureka Underwriters" Best Linen Hose will have a special woven trade-mark, *Red, White, and Blue*, woven in, and branded with black letters every fifteen feet, and with serial letters from A to L, which represent the months January to December, and year of its manufacture, so the genuineness and date of its manufacture can be assured.

"U. S." BRAND Cotton Rubber Lined Factory Fire Hose.

This brand of Rubber Lined Cotton Factory Fire Hose was made in accordance with the recommendations of Mr. JOHN A. FREEMAN, Hydraulic Engineer and Inspector of the "Associated Factory Mutual Insurance Companies" of Boston. In addition to its being branded "U.S.," every length will have a special mark, *Red, White, and Blue*, woven in, to distinguish it. All parties desiring a first-class and reliable Factory Fire Hose should specially require the "U.S." brand, and accept no other.

SAMPLES AND PRICES ON APPLICATION.

EUREKA FIRE HOSE CO.,

P.O. Box 1330. **No. 13 Barclay St., New York.**

80,000

WATER METERS MADE AND SOLD BY

National Meter Company,

252 Broadway, New York.

SEPT., 1890. **JOHN C. KELLEY, Pres.**

The following facts and figures are taken from the Reports, as published, from the "office of the Department of Public Works, City Hall, Providence, R.I."

NUMBER OF WATER METERS IN USE.

Year ending March 31, 1888.		*Year ending March 31, 1890.*		
Ball & Fitz Piston	3,742	3,789, Increase		47
" " Rotary	61	58, Decrease		3
CROWN	3,801	4,925, Increase		1,124
Fales, Jenks, & Sons	27	6, Decrease		21
Worthington	62	29, Decrease		33
Total	7,693	8,807		

Total increase of Meters ... 1,114 for 2 years.
" " **CROWN** Meters ... 1,124 " "

Meters bought ... 1,171
Meters removed ... 57

Total increase ... 1,114, or 14 5/10 %.

Actual number of Taps to March 31, 1888 ... 13,097
" " " " " 1890 ... 14,305

1,208. Increase 9 %.

Percentage of Taps metered, 1890 ... 61 5/10 %.
" additional Taps metered ... 92 %.

AVERAGE DAILY CONSUMPTION.

Consumption.		*Water Receipts.*	
For 1887	4,939,982 gallons.	For 1887	$339,513 60
For 1889	5,786,961 gallons.	For 1889	377,497 97
Increase	846,979 gallons.	Increase	$37,984 37

PRICE OF WATER.

Providence, R.I., received for all water for the year 1887, at the rate of $188.41 per million gallons. For the year 1889 at the rate of $178.74 per million gallons. This city in 1888 made a reduction in rates to large users.

Number of Meters in use, 1888 ... 7,693
" " " 1890 ... 8,807

"This increase is paid by actual users. While in other cities (Rochester included) there is a frontage tax, etc."

TAKEN FROM ANNUAL REPORTS.

Philadelphia, Pa., received for all water for year 1887, at the rate of $62.61 per million gallons.
Number of Meters in use 1887 ... 280

Fall River, Mass., received for all water, year 1889, $177.85 per million gallons.
Number of Meters in use, 1889 ... 3,426

Lowell, Mass., received for all water for the year 1889, at the rate of $111.84 per million gallons.
Number of Meters in use, 1889 ... 1,757

Buffalo, N.Y., received for all water for year 1888, $31.83 per million gallons. For year 1889, $33 per million gallons.
Number of Meters in use, 1888 ... 87
" " " 1889 ... 115

Richmond, Va., received for all water for year 1888, at the rate of $28.24 per million gallons.
Number of Meters in use, 1888 ... 85

New York, N.Y., received for all water for the year 1887, at the rate of $66.21 per million gallons. (Supply estimated.)
Number of Meters in use, 1887 ... 16,552
" " " March 31, 1890. 20,348

Lawrence, Mass., received for all water, year 1889, $84.57 per million gallons.
Number of Meters in use, 1889 ... 1,213

Troy, N.Y., received for all water for year 1889, at the rate of $29.95 per million gallons.

AUTOMATIC SUPPLEMENTARY OR DOUBLE VALVE

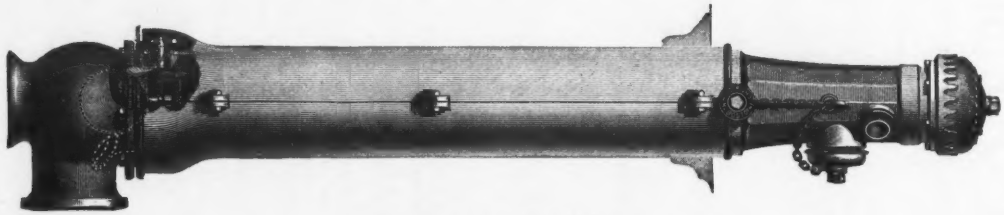
FIRE HYDRANTS.

Also Constructed with

Single Main Valve.

Formerly built by the Boston Machine Co., and Boston Machine Mfg. Co.

(CARR'S PATENTS.)



Manufactured only by

CHARLES CARR,

(SOLE OWNER OF PATENTS.)

OFFICE, 7 EXCHANGE PLACE, - - BOSTON, MASS.

CARR'S

FIRE

ADVERTISEMENTS.

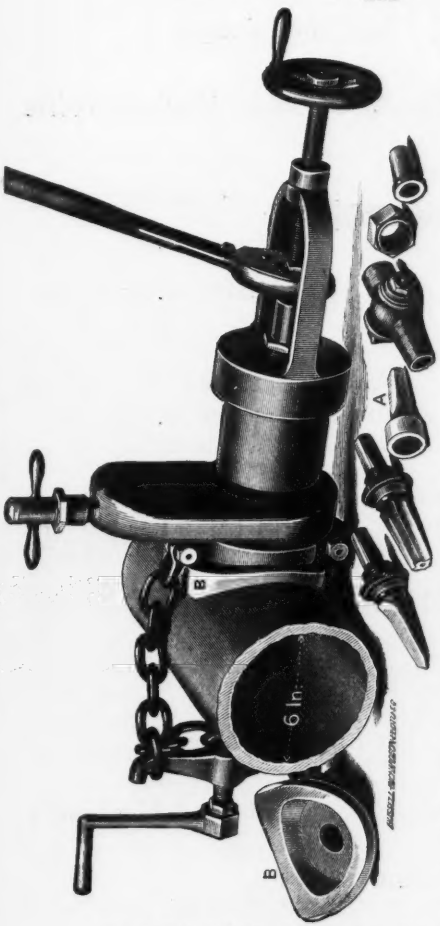
THE POPULAR AND DURABLE

E. R. JONES'

TAPPING MACHINE

No other equals it in efficiency or durability,

AND



The following are among the cities and towns using this Tapping Machine: Auburn, Bangor, Bar Harbor, Brewer, and Old Town, Me.; Dover, Littleton, Nashua, N.H.; Morrisville, St. Johnsbury, Waterbury, Vt.; Boston, Brookline, Cambridge, Charlestown, Clinton, Everett, Fall River, Fitchburg, Holyoke, Haverhill, Lowell, Lawrence, Leominster, Marlboro', Maynard, Milford, Newton, New Bedford, North Adams, North Bridgewater, North Attleborough, Norwood, Springfield, Taunton, Waltham, Westfield, and Worcester, Mass.; Pawtucket, Providence, Westerly, R.I.; Norwich, Conn.; Hornellsville, Hudson, Mt. Morris, Norwich, New Berlin, New Rochelle, Oneida, Oswego, Rochester, Troy, and Yonkers, N.Y.; College Point, Flushing, and Long Island City, L.I.; Atlantic City, Bayonne, and Jersey City, N.J.; Norristown, Penna. Steel Co., Sayre, Pa.; Wilmington, Del.; Cincinnati, Columbus, Dayton, Ironton, Martin's Ferry, Portsmouth, Sandusky, and Toledo, Ohio; Belleview, Covington, Henderson, Maysville, and Newport, Ky.; Evansville, Ind.; Jackson, Mich.; Milwaukee, Wis.; St. Joseph and Sedalia, Mo.; Jacksonville, New Orleans, La.; Salt Lake City, Utah; Sacramento, Cal.; Fredericton, N.B.; Barbadoes, W.I., and many others.

DUPLICATE PARTS FURNISHED.

Carr's Patent Automatic Supplementary or Double Valve Hydrant,

Always Reliable and Operative. Also Single Valve Hydrants. Manufactured only by

CHARLES CARR,

SOLE OWNER OF PATENTS.

Office, 7 Exchange Place, Boston.

R. D. Wood & Co.

Engineers,

Iron Founders,

and Machinists.

Office: 400 Chestnut Street, Philadelphia.

FIRE HYDRANT
WITH CRANE ATTACHMENT FOR SPRINKLING CART.

Foundries and Works: { MILLVILLE, FLORENCE, CAMDEN, } N. J.

Constructors of Water and Gas Works.

MANUFACTURERS

—OF—

CAST IRON PIPE

TURBINE WHEELS,

Pumping Machinery,

Hydraulic Cranes,

Lifts and Machinery,

Heavy Loam Castings,

"Eddy" Valves,

"Mathews'" Hydrants.

The American Frost Meter Co.,

OWNING AND CONTROLLING ALL

VERTICAL PISTON METERS.

These Meters are the most DURABLE, ACCURATE, and RELIABLE Meters built — requiring no repairs or attention, and will register accurately on the finest stream. They are the only Meters which received the unqualified approval of the Meter Testing Commission of the city of Boston.

82, 84, 86, 88, & 90 Lenox st., Boston, Mass., U.S.A.

P.O. Box 3659. Write for Circular and Price List.

CHADWICK LEAD WORKS,

Nos. 176, 178, 180, 182, and 184 HIGH STREET (Fort Hill Square),

BOSTON, MASS.,

MANUFACTURERS OF AND DEALERS IN

LEAD PIPE, TIN PIPE, SHEET LEAD,
SHEET TIN, RIBBON AND TAPE LEAD,
WHITE LEAD, Dry and in Oil, RED LEAD,
LITHARGE, COPPER AND IRON PUMPS,
SOLDER, PIG LEAD, PIG TIN, ETC., ETC.

☞ **Lead encasing Electric Cables and Wires a Specialty.**

Proprietors of

THE FOREST RIVER LEAD WORKS,

SALEM, MASS.

Correspondence with Water Works solicited.

Samuel Little, President. William J. Bride, Treasurer.

BOSTON LEAD MANUFACTURING COMPANY,

Corner of Congress and Franklin Sts.,

162 Congress St. BOSTON. 180 and 182 Franklin St.

Manufacturers of

White Lead, Red Lead and Litharge
Patent Tin-Lined Lead Pipe,
Pure Block Tin Pipe.

Lead Pipe and Sheet Lead.

Also Dealers in

Pig Lead, Pig Tin, Solder, Pumps, Etc.

Has an unparalleled Record of more than Fifty Years.

SALES IN THE UNITED STATES, 5,000,000 BARRELS.

"HOFFMAN" ROSENDALE CEMENT.

FROM THE

BEST ROCK.

ADAPTED FOR

Heavy Masonry.

ALWAYS

RELIABLE.

STANDS EVERY

HIGH TEST.

UNIFORM IN

QUALITY

AND

Full Weight.

TAKES THE LEAD OF AMERICAN CEMENTS.

Extensively used by the U.S. Government.

Receives the approbation of the most eminent

ENGINEERS AND ARCHITECTS.

Send for Pamphlet of valuable information to

M. Albert Scull, Ernest R. Ackerman, } General Sales Agents. LAWRENCE CEMENT CO., 67 Williams St., New York.

SOME MATTERS OF INTEREST

REGARDING THE

Thomson Water Meter.

THE CITY OF DETROIT'S Water Commissioners' representative, T. H. Putnam, Esq., under date of July 17, 1890, writes as follows: —

"We removed one of your 1-inch meters, No. 1765, it having been in service just two years. It had registered 321,040 cubic feet. We tested it and found that it was *very nearly perfect*, and are very much pleased with the showing."

In reply to our request for permission to use the above as a testimonial, we received the following: —

"Have no objection to the publishing of our test of your 1-inch meter, *as they give us less trouble than any others we have in use.*"

ABOUT ONE YEAR AGO A. W. F. Brown, Esq., Water registrar of Fitchburg, Mass., started a durability trial of a ⅝-in Thomson Meter, No. 3250, and at a number of intervals has tested it for accuracy, finding no practical variance up to the last test of Aug. 25, 1890. At that date the meter had delivered 807,789 cubic feet, but it yet registered as follows: —

Diameter of Discharge.	Error in per cent.	
	Plus.	Minus.
3/8	2.0	
1/4	. .	1.0
5/32	0.5	
1/8	2.0	
3/32	0.5	
1/16	4.5	
1/32	11.0	

It may be interesting to note that the above performance of a ⅝-inch meter required approximately 240,000,000 movements of the disk, and to be equalled by a 1-inch meter would necessitate the discharge of nearly 3,400,000 cubic feet.

The performance of the Thomson Meter is fully warranted under contract. 'NO GO; NO PAY.

Complete descriptive Catalogue on application. Address

THOMSON METER COMPANY,

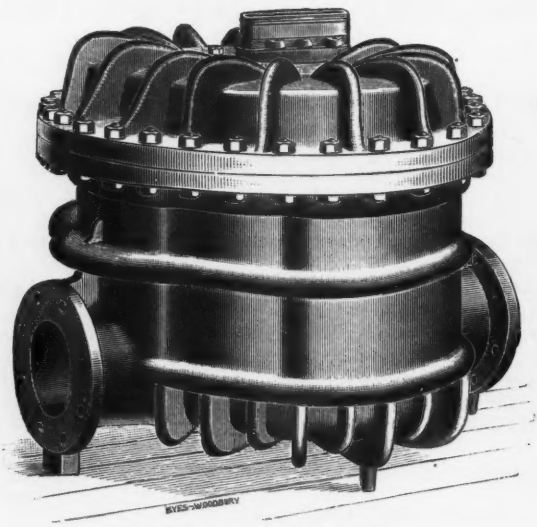
212 TEMPLE COURT, Nassau and Beekman Streets, NEW YORK.

UNION WATER METER CO.,

WORCESTER, MASS.

ESTABLISHED IN 1868.

81,000 Made and Sold.



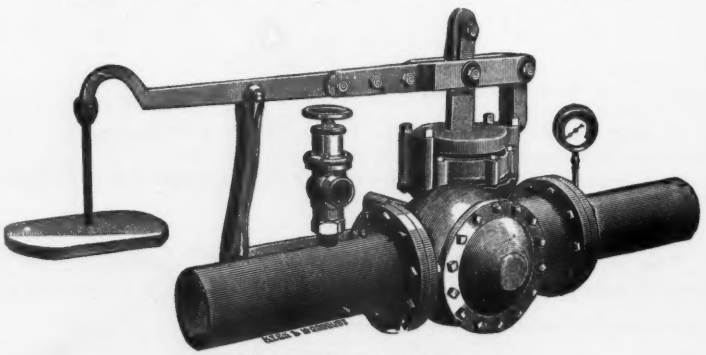
Man'f'rs of the only positive MEASURING 12-in. METERS.

Extra Heavy Rotary Piston Meter.

ROTARY AND RECIPROCATING PISTON

WATER METERS.

Sizes 5-8 inch to 12 inches. Send for Catalogue, etc.

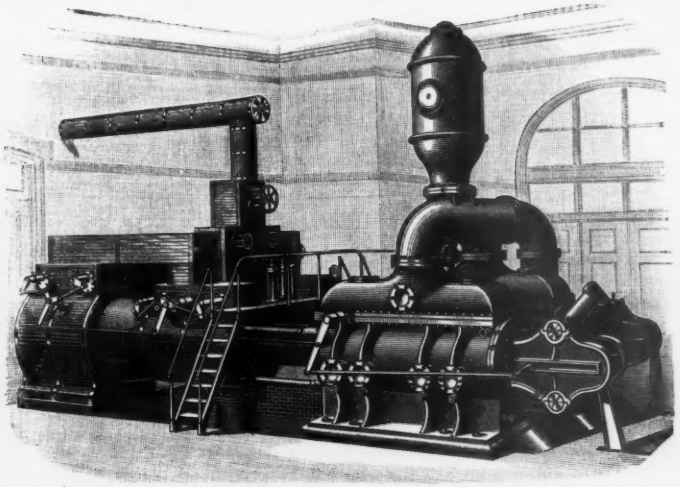


Water Pressure Regulator.

The only positive Automatic Water Pressure Regulator in the market. We have never had a failure.

Write for Lithotype, etc.

THE WORTHINGTON
High Duty Pumping Engine.



DUTY OBTAINED, OVER 110 MILLION FOOT POUNDS.

HORIZONTAL, VERTICAL, OR BEAM.

Regular Compound
OR **Triple Expansion.**

Lowest First Cost and Maintenance.

HIGHEST ECONOMY.

Total Daily capacity of WORTHINGTON PUMPING ENGINES now in service,

Over 2,000,000,000 Gallons.

An Illustrated Pamphlet descriptive of the Worthington Pumping Engines will be furnished on application to

HENRY R. WORTHINGTON,

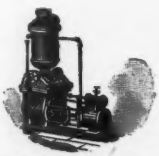
86 and 88 Liberty Street, 145 Broadway,

NEW YORK CITY.

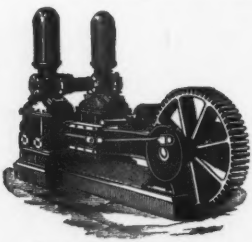
KNOWLES STEAM PUMP WORKS,

BUILDERS OF

PUMPING MACHINERY.



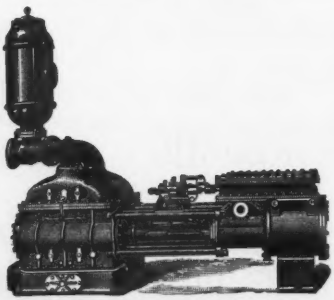
PUMP AND CONDENSER.



GEARED POWER PUMP.

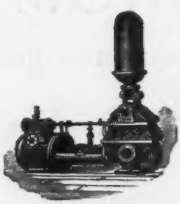
BOILER FEED PUMP.

STEAM AND POWER.

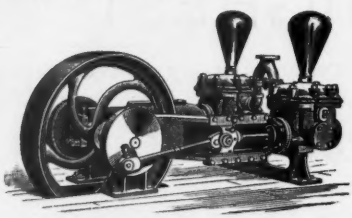


DUPLEX COMPOUND ENGINE.

SINGLE AND DUPLEX.



PRESSURE PUMP.



DUPLEX BELT PUMP.

BOSTON:
111 and 113 FEDERAL STREET.

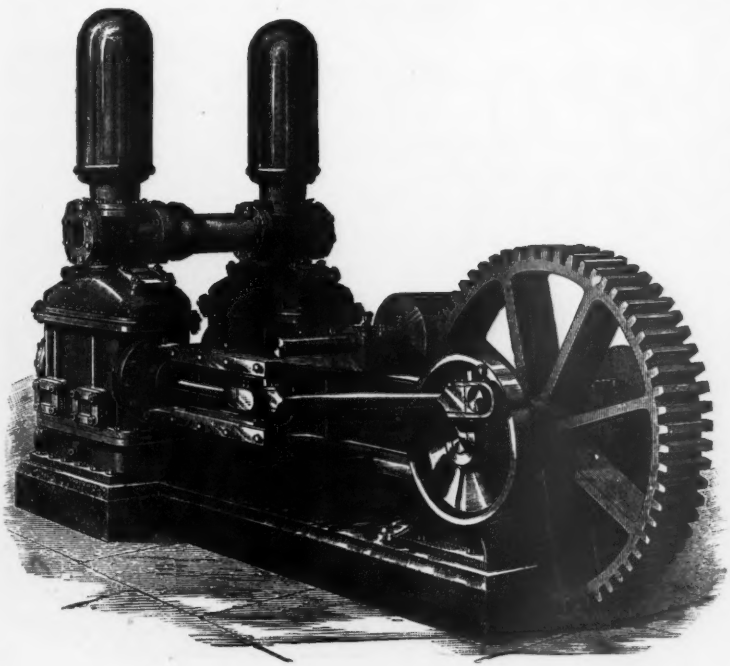
NEW YORK:
93 LIBERTY STREET.

GEO. F. BLAKE MFG. CO.,

BUILDERS OF

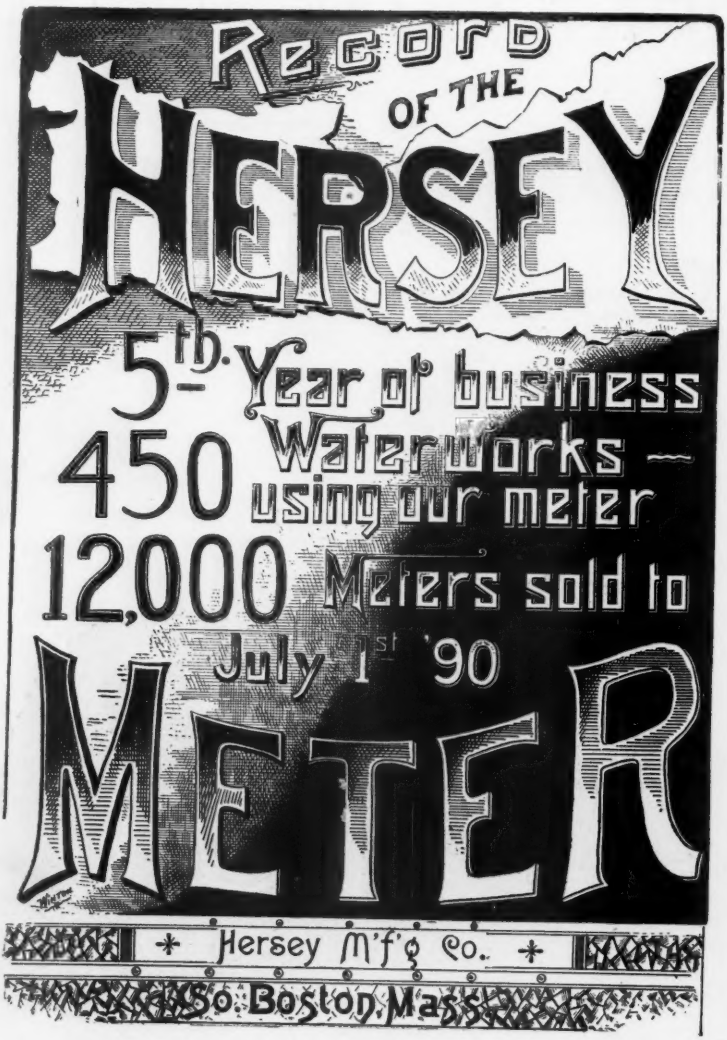
STEAM AND POWER

Pumping Machinery



111 and 113 Federal Street,
BOSTON.

95 and 97 Liberty Street,
NEW YORK.


Record of the
HERSEY
5th Year of business
450 Waterworks using our meter
12,000 Meters sold to
July 1st '90
METER
Hersey M'f'g Co.
So. Boston, Mass.

ESTABLISHED 1856.

Warren Foundry and Machine Co.

WORKS AT PHILLIPSBURG, NEW JERSEY.

Sales Office, 160 Broadway, New York.

Cast Iron, Water and Gas

PIPE,

From 8 to 48 Inches Diameter.

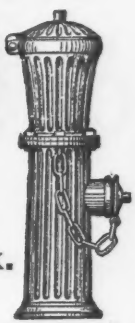
—ALSO—

ALL SIZES OF FLANGED PIPE,

—AND—

SPECIAL CASTINGS.

M. J. Drummond.



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Stop Valves, Fire Hydrants,
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"Globe" Specials.

Office, Corbin Building, 192 Broadway, New York.

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Cast-Iron Gas and Water Pipes,

1½, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20, 24, 30, 36, and 48 Inches Diameter.

CAST-IRON FLANGE HEATING AND STEAM PIPES.

2, 3, 3½, 4, 5, 5½, 6, 7, 8, 10, 12, to 48 Inches Diameter.

Fire Hydrants and Stop Valves for Water or Gas, all Sizes.

Loam, Special, and Sugar-House Castings.

ALL PIPE PROVED BY HYDROSTATIC PRESSURE.

GEORGE ORMROD, Manager and Treas., Emaus, Pa.

JOHN DONALDSON, President, 226 Walnut St., Phila., Pa.

EMAUS PIPE FOUNDRY.

DONALDSON IRON CO.,

MANUFACTURERS OF

CAST IRON PIPE,

FOR WATER AND GAS.

ALSO

SPECIAL CASTINGS.

EMAUS, Lehigh Co., Pa.

WE CARRY IN STOCK
AND SELL BY THE PIECE,

Special Castings.

We have one of the best Boiler-Shops in New England,
and make every variety of

Steam Boilers and Tanks.

THE TAUNTON LOCO. MANFG. CO.,

WM. R. BILLINGS, Treas. TAUNTON, MASS.

Globe Special Castings.

CARRIED IN STOCK.
CHEAPER THAN OLD FORM.

BUILDERS' IRON FOUNDRY,
PROVIDENCE, R.I.

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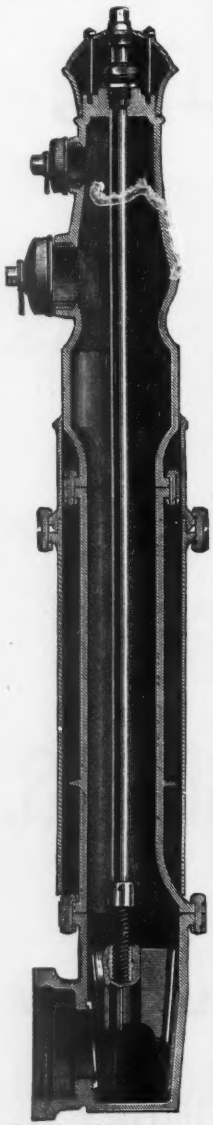
—MANUFACTURERS OF—

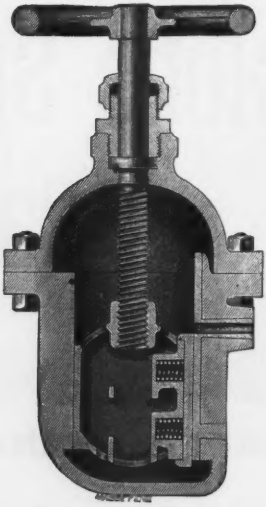
VALVES AND GATES FOR WATER, GAS, STEAM, &C.

GATE FIRE HYDRANTS.



Section Hydrant.

Bell End Water Gate.



Section Drip Valve.

Hydrant.

ALL WORK GUARANTEED.

General Manager's Office and Works, Indian Orchard, Mass.
Treasurer's Office, 72 Kilby Street, Boston.

Walworth Manufacturing Co.,

16 to 20 Oliver Street, Boston, Mass.

FOR WATER WORKS.

Galvanized, Enameled and Plain

IRON PIPES and FITTINGS,

Gates, Brass and Iron Valves, Cocks, Etc., Etc.

CORPORATION AND STOP COCKS, TOOLS AND SUPPLIES.

Morgan's Extension Shut-off Boxes (New England Agents).

Miller's Ratchet Pipe Cutting and Threading Tools.

Stillson and Ashley Grip Wrenches.

THE HALL TAPPING MACHINE.

Made of Composition.

Simplest and Best.

For tapping street mains under pressure and inserting service cocks without shutting off water or gas.

We claim for it many advantages over others.

Our one machine does the work usually requiring *two or three.*

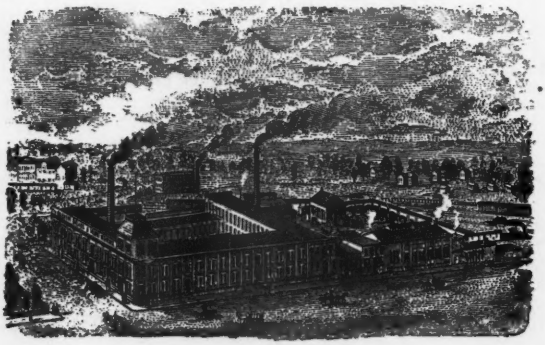
It can be used on mains ranging from *four* to *sixteen* inch (and upwards). Will stand any pressure, and service cocks of almost *any make* may be used; thus its usefulness *is not* limited to the supply of a certain cock. It takes ½ inch, ⅝ inch, ¾ inch, 1 inch, 1¼ inch cocks, and meets any ordinary requirements.

Send for Circular giving Description of its Working Principle, which is Simple and Correct, or Call and Examine it.

WE WARRANT OUR WORK.

GALVIN BRASS AND IRON WORKS,

Office and Works:



Cor. Warren Ave. and 15th St., DETROIT, MICH.

Sole Manufacturers of the

GALVIN PATENT COMPOUND WEDGE GATE VALVES

For Water, Steam, Ammonia, Gas, Oil, Etc.

CONICAL COMPOUND WEDGE GATE HYDRANTS,

Also Improved Compression Fire Hydrants,

FOOT VALVES, CHECK VALVES, ETC.

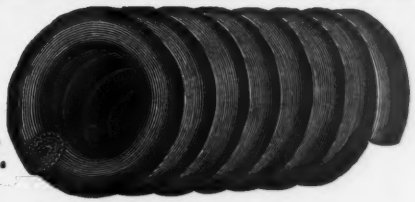
General Brass and Iron Goods for

STEAM, WATER AND GAS.

Write for Catalogue and Price List.

RANDOLPH BRANDT,

38 CORTLANDT ST.



NEW YORK.

MANUFACTURERS OF THE

SELDEN PATENT PACKING

(with and without Rubber Core),

For Stuffing-Boxes on Plungers, Piston-Rods, and Valve-Stems.

These packings are made of carefully selected materials, FREE FROM GRIT, and are

SELF-LUBRICATING AND ELASTIC.

The following are a few of the representative houses who use and recommend the Selden Packing: Knowles Steam Pump Works, Pumping Machinery; George F. Blake Mfg. Co., Pumping Machinery; The Jno. H. McGowan Co., Pumping Machinery; Geo. J. Roberts & Co., Pumping Machinery; The Hooven Owens & Rentschler, Hamilton Corliss Engines; The Ritchie & Dyer Co., Stationary and Portable Engines.

C. R. WOODIN, President. WM. F. LOWRY, Treasurer.
C. H. ZEHNDER, Vice-Pres. and Gen. Mgr.
FRED'K H. EATON, Secretary. H. F. GLENN, Gen'l Supt.

THE JACKSON & WOODIN MFG. CO.,

MANUFACTURERS OF

Cast Iron Water and Gas Pipe,

Special Castings, Lamp Posts, Car Wheels, Cars, Merchant Iron and Forgings.

BERWICK, COL. CO., PENNA.

THE DEANE,

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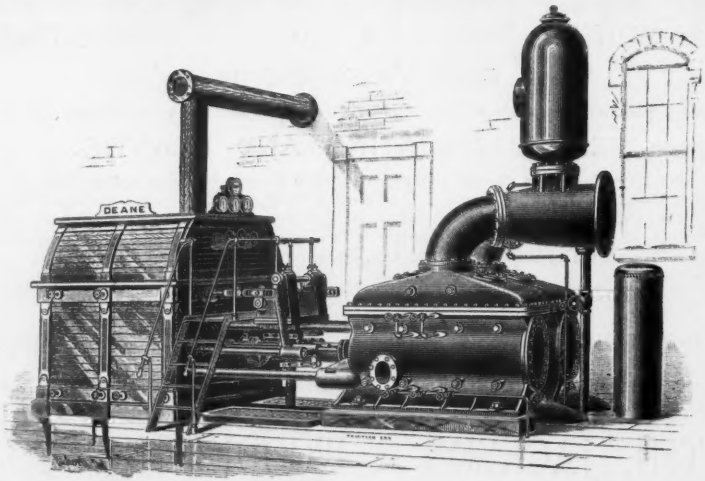

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The Journal of the New England Water Works Association

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The Secretary would be pleased to give further information to any one desiring the same. Address,

R. C. P. COGGESHALL,
Secretary New England Water Works Association,
New Bedford, Mass.